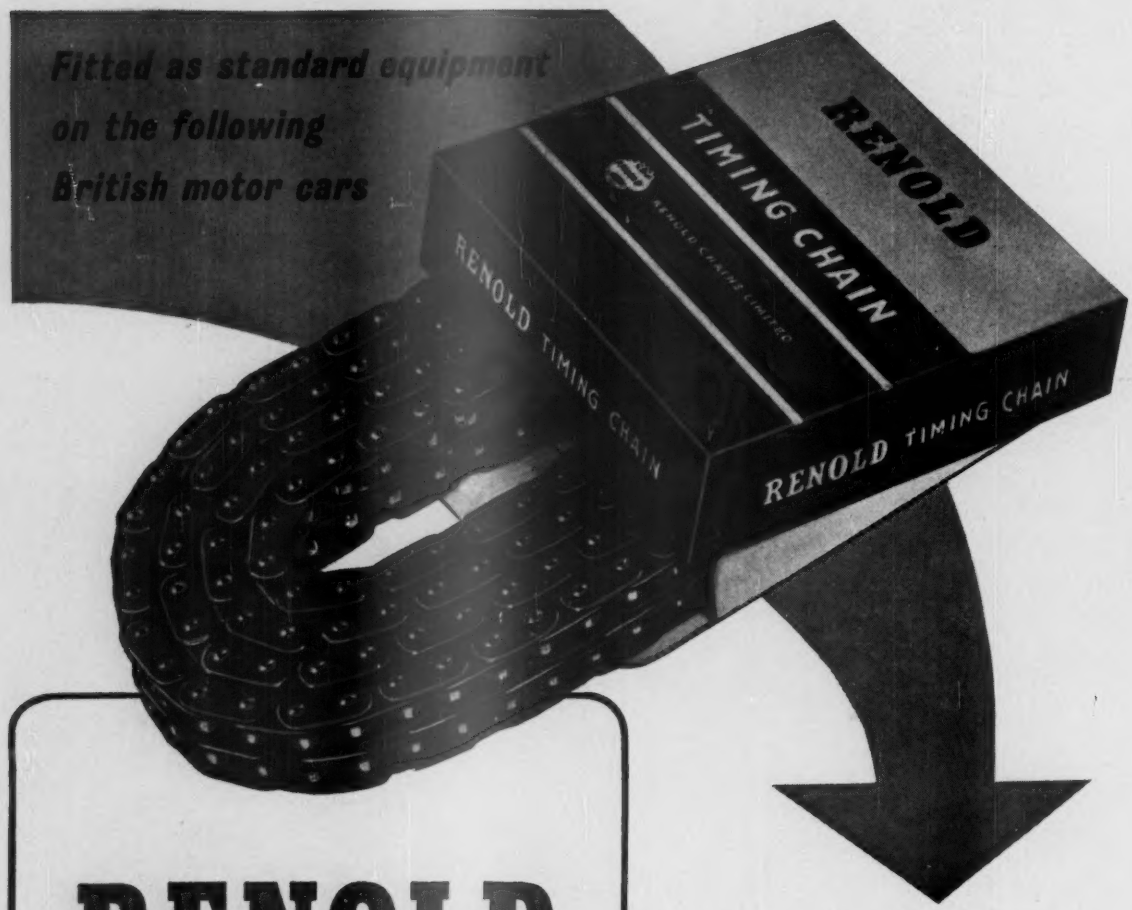
AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 47 No. 5 MAY 1957 PRICE: 3s. 6d.

Fitted as standard equipment on the following British motor cars



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DRILLING MACHINES
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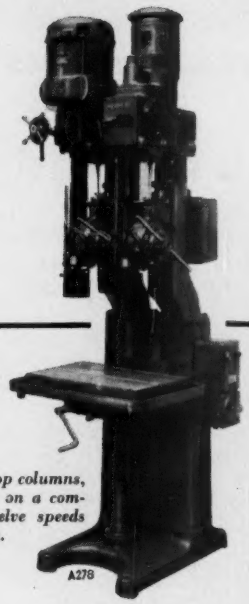
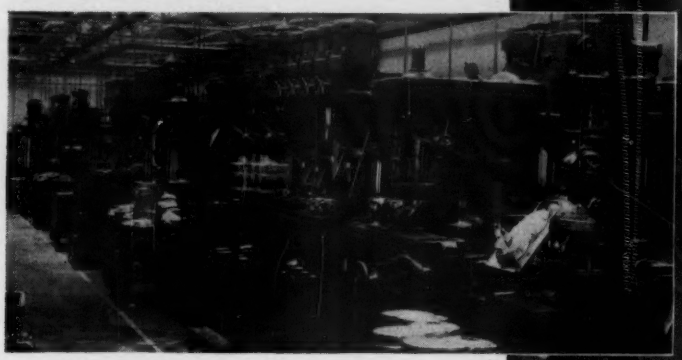
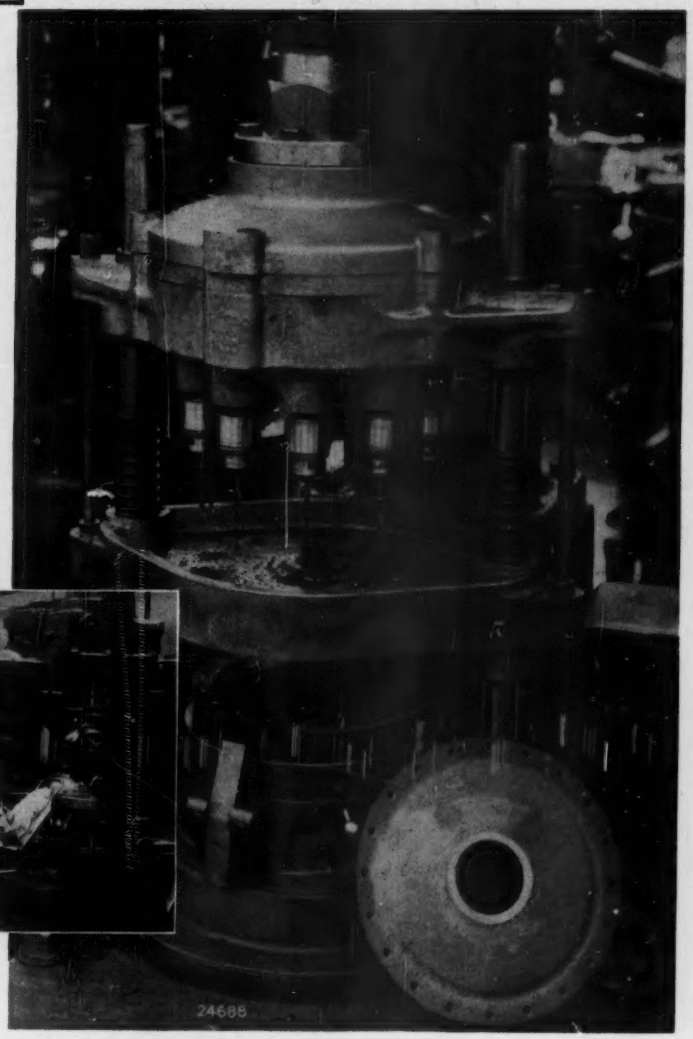


Type V and C top columns, automatic feeds, on a common base. Twelve speeds 36 to 2850 r.p.m.

Unit construction of Herbert All-electric Drilling Machines provides a very wide range of machines without resource to specialisation. The range is sufficiently extensive to meet the demands for most general-purpose drilling and tapping requirements and to provide a basis from which to build special-purpose machines. Top columns can be supplied to customers for fitting to their own bases.



Line production including Herbert Types C and V Single and Multi-spindle Drilling Machines and Archdale Milling Machines for producing a variety of motor-cycle components in the Coventry Works of the Triumph Engineering Co. Ltd.



BRAKE DRUMS. An indexing workholding fixture and a 10-spindle multi-drill head on a Type C machine for drilling twenty $\frac{5}{64}$" diameter holes on the outer rim in a total time of 1·5 minutes.

These drilling machines incorporate many labour- and time-saving devices and can include such refinements as automatic reversing attachment for tapping, quick-change drill chuck and automatic feeds. Most types are fitted with a drill depth indicator and alternative ranges of speeds and feeds are offered. There are eight types for drilling holes from the very smallest, at 18,000 r.p.m., up to $1\frac{1}{4}$ in. diameter.

ALFRED HERBERT LTD · COVENTRY · ENGLAND

AD 276

still undecided?

Indecision is not an uncommon failing. Indeed, many of us in one direction or another will continue to dither, even when faced with indisputable facts.

For instance, it may be perfectly obvious that the tapping screw offers many advantages over the conventional machine screw ; that it eliminates costly thread cutting operations all along the production line ; that it ensures easier assembly ; that for joining metal, wood or plastic, it is stronger, cheaper and faster.

Such facts being recognised and accepted, that the tapping screw makes a stronger, swifter, cheaper, easier, safer and better-looking product — in any material, there seems but one course of action. You're right. Change over to tapping screws ! Still undecided !

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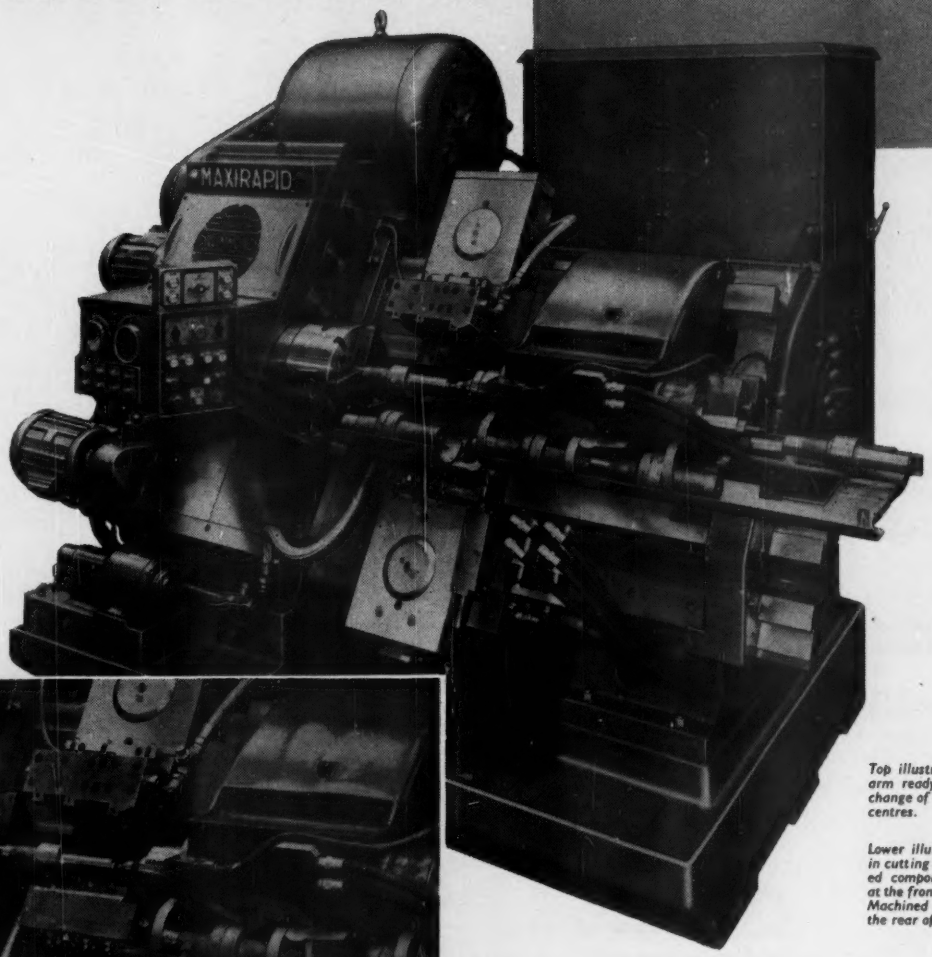
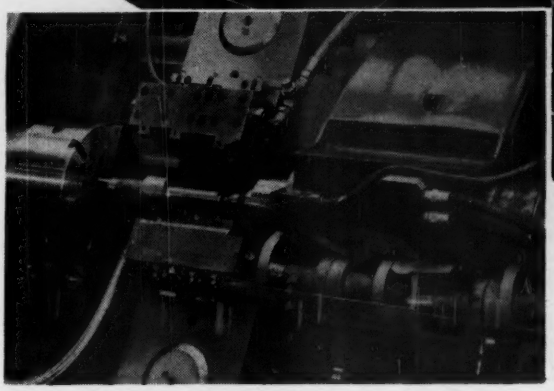
designed specifically for fully automatic high output production





Top illustration shows loading arm ready for automatic exchange of components between centres.

Lower illustration shows slides in cutting position. Unmachined components can be seen at the front of the loading unit. Machined parts are ejected at the rear of unit.

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GUILDFORD · ENGLAND

The illustrations above show the "Maxirapid" tooled up for turning forged steel final-drive pinions. This example demonstrates the possibilities of the machine for really high speed heavy duty production.

Full advantage is taken of the adequate power and rigidity of the "Maxirapid," carbide tools being employed for all turning operations, and automatic loading and unloading is provided. Maximum swing over bed of the "Maxirapid" is 17 ins. and maximum distance between centres 24 ins. A 25, 35 or 50 h.p. motor can be fitted.

The illustrations show the machine with splash guards removed.

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The four 2-way horizontal and one single way horizontal hydraulic machines — each with one load and two work stations, as illustrated, are a part of a complete transfer lineup designed to perform all machine operations on automotive transmission cases for a large American plant. With a production schedule of 80 automotive transmission cases per hour this lineup drills, reams, counterbores, countersinks, rough bores, semi-finish bores and taps holes in both the single and double bore sides of case. Automatic turnover fixture is provided, prior to last machine in lineup, to index case into exact position for tapping all holes in bottom face.

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This size of Lockheed
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THE TECHNICAL PRESS SPEAKS VERY HIGHLY OF THE LOCKHEED 7 INCH BRAKE.

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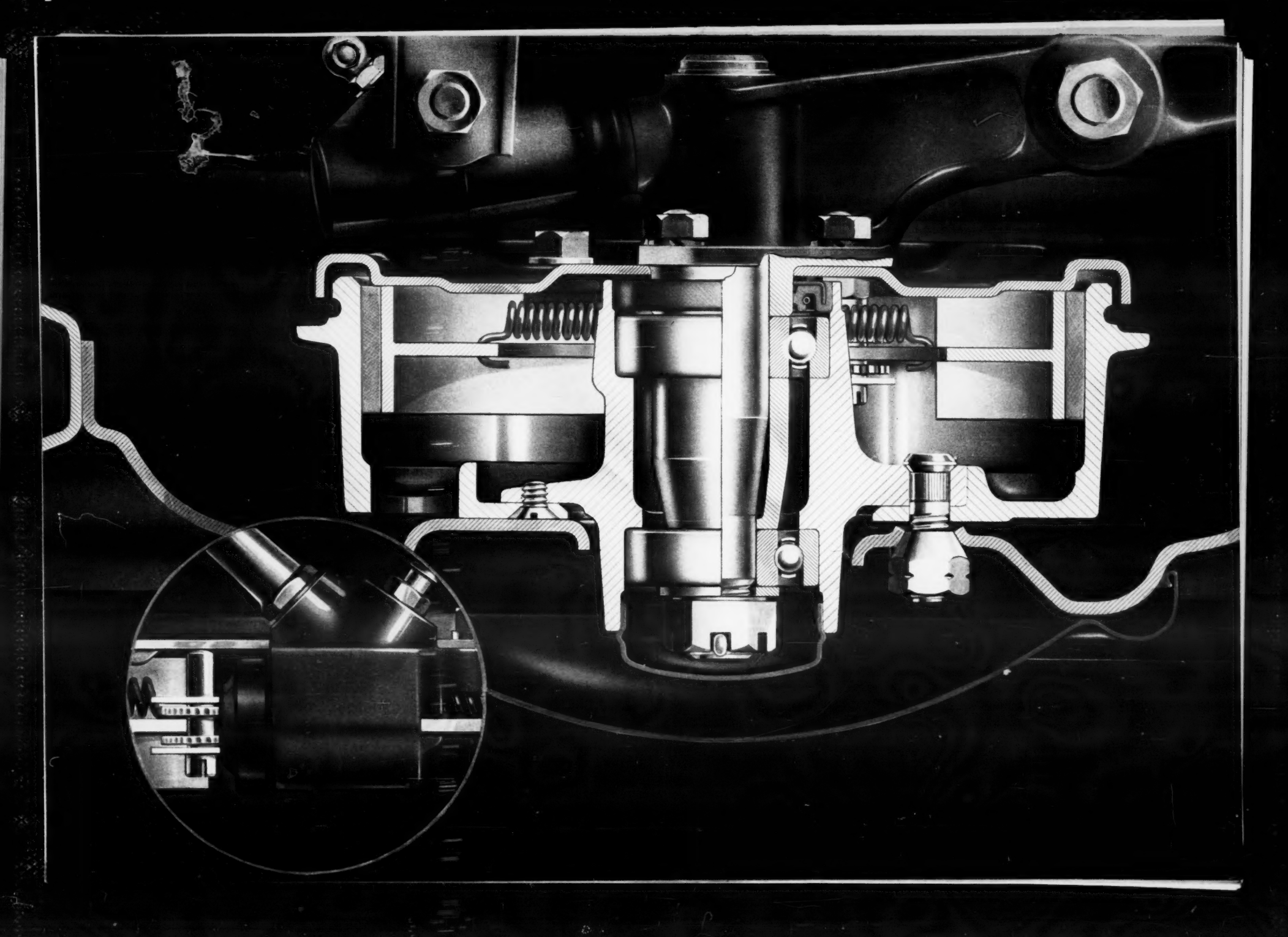
'The Autocar', *after testing the A-35, said 'The brakes were up to all that was required of them during the Road Test. Only a light pressure was needed for all normal braking.'*



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The above illustration [illegible] in actual size from which [illegible] stem. A section is also shown [illegible] This clutch has a capacity [illegible] of the other Borg & Beck [illegible] cover, being made from [illegible] pressed steel to [illegible] sufficient to be considered [illegible] actual power requirements [illegible] The clutch is very easily [illegible] Further particulars will be [illegible]

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Sir, you are living in the past. This Little Horse here *(" this 'ere Little Horse, if you please " muttered the Little Horse in question)* operates a screwdriver. Note that we have fitted him with a kind of gag or muffler, thus reducing the operating noise level by more than 50%. The principle is really very simple—as I will now demonstrate. I place this muffler over my mouth . . . so . . . I will now ask any member of the audience to wrap the ends—thank you, sir,—round behind my ears . . . and N'mm M'mm Er'rm Ah'rmm Hurh'mm mm-m-mm . . . !

(The audience agreed that the noise level had indeed dropped by well over 50% and the Managing Director was carried out, black in the face, amid loud cheers).

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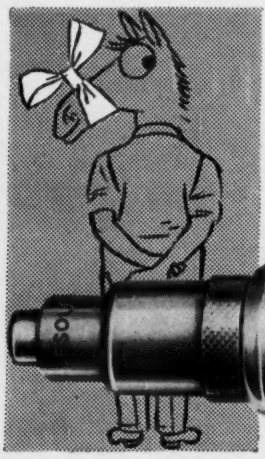

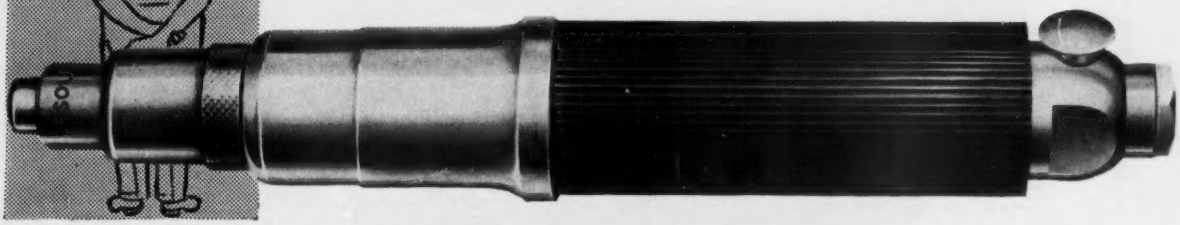

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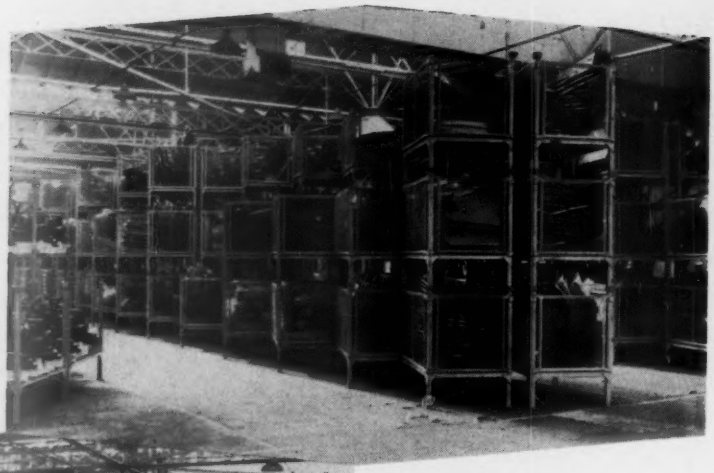

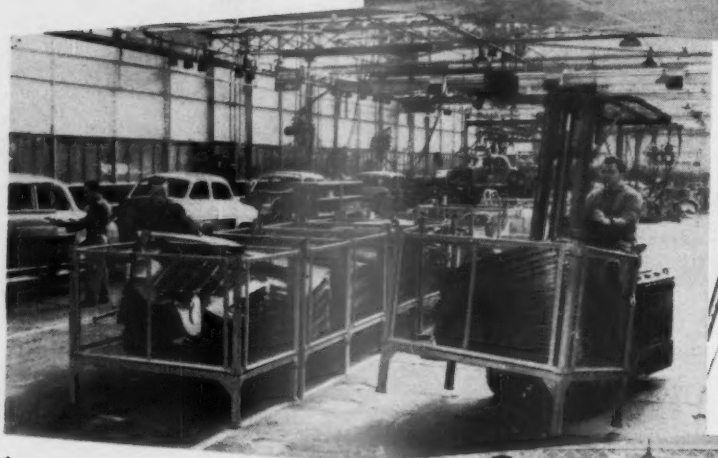

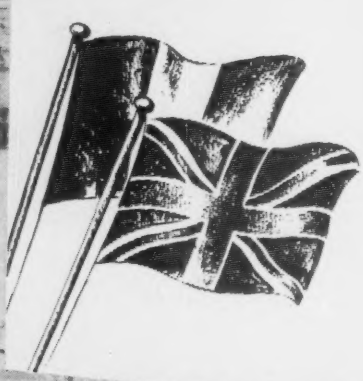

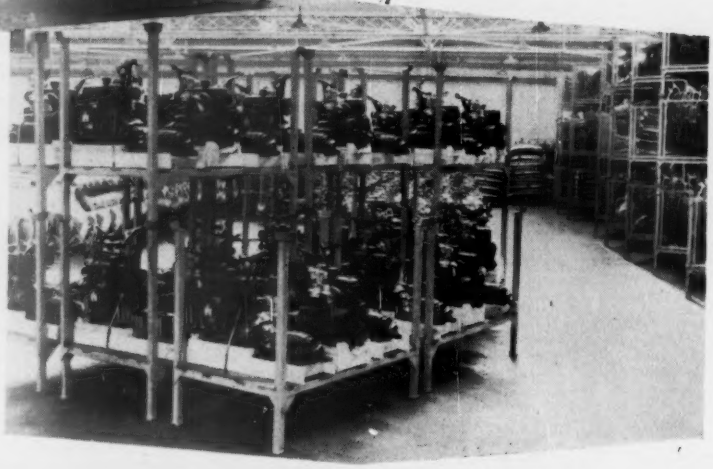

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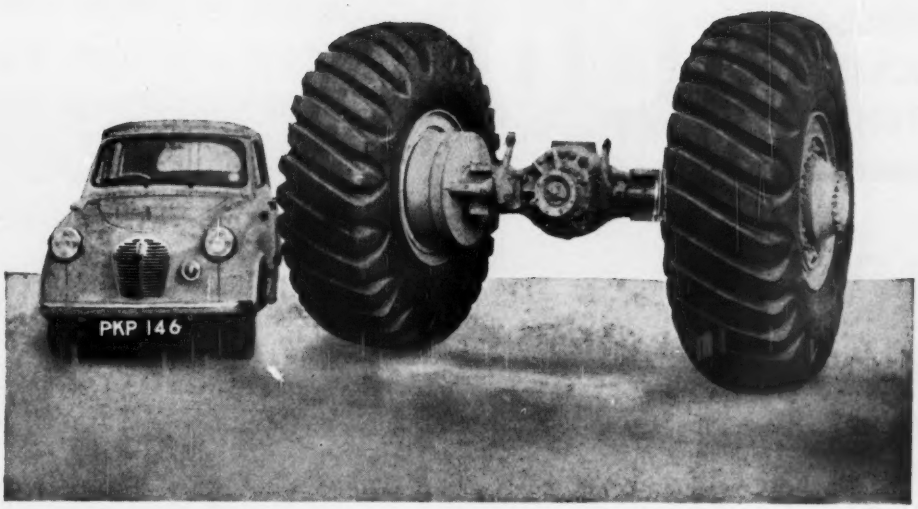

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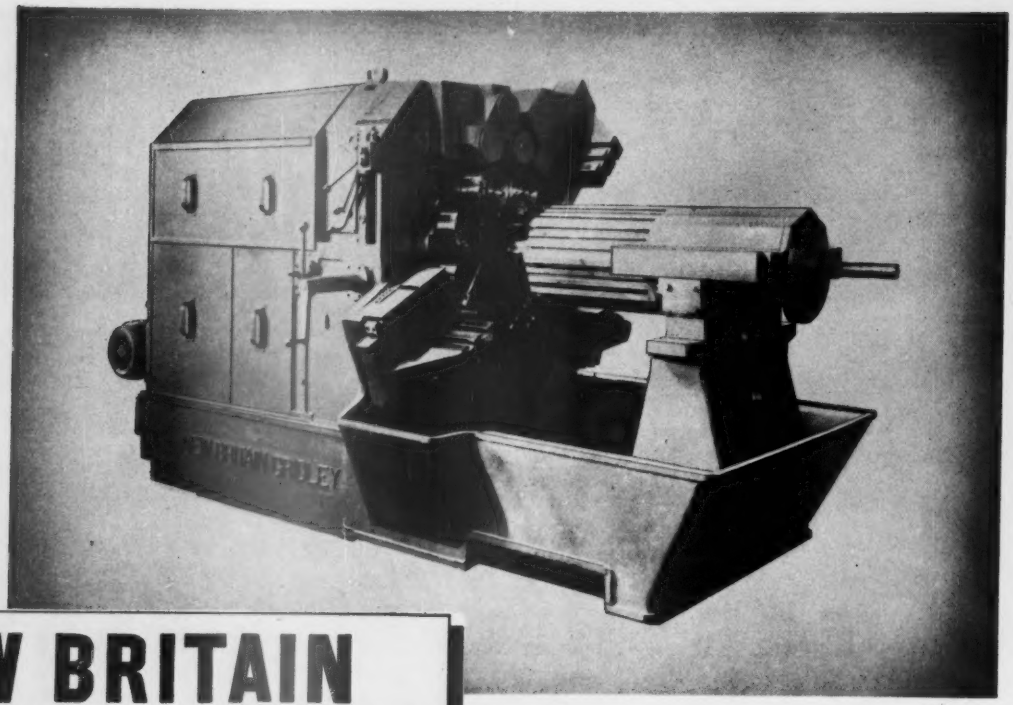

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And of course you save all the time on fuel and engine wear, to say nothing of the comfort and ease of mind which comes from always being on top of the job.

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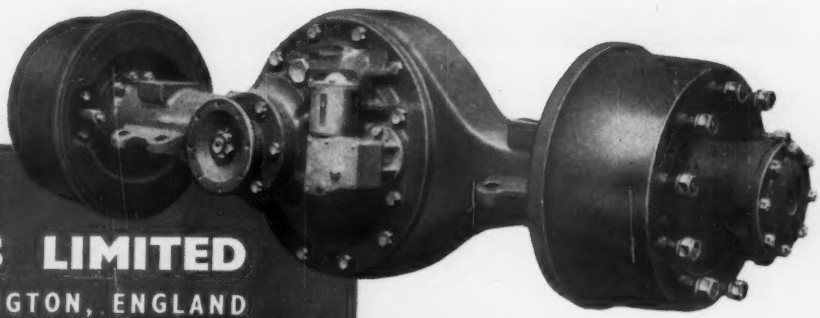

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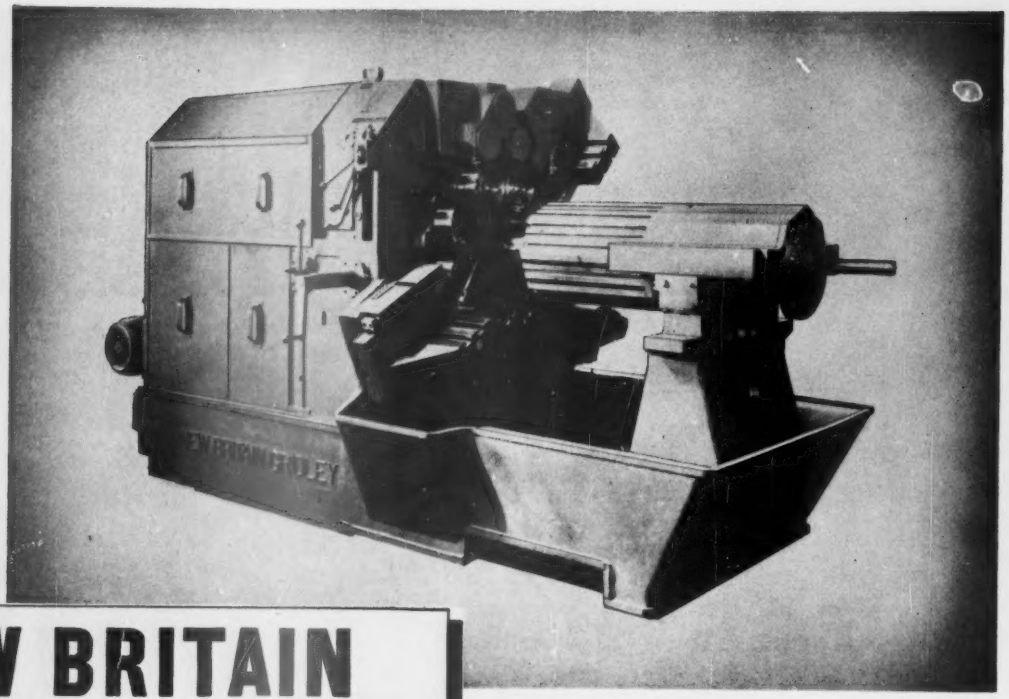

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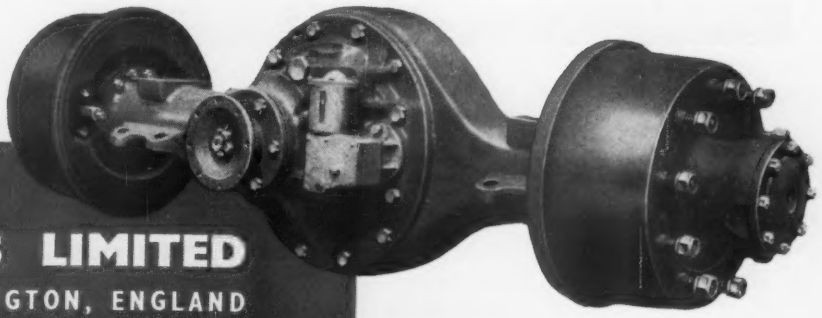

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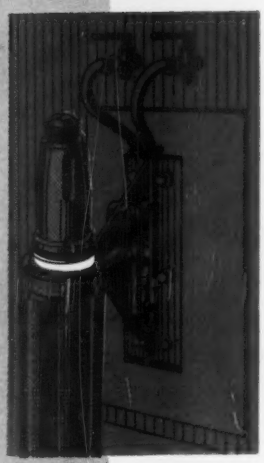

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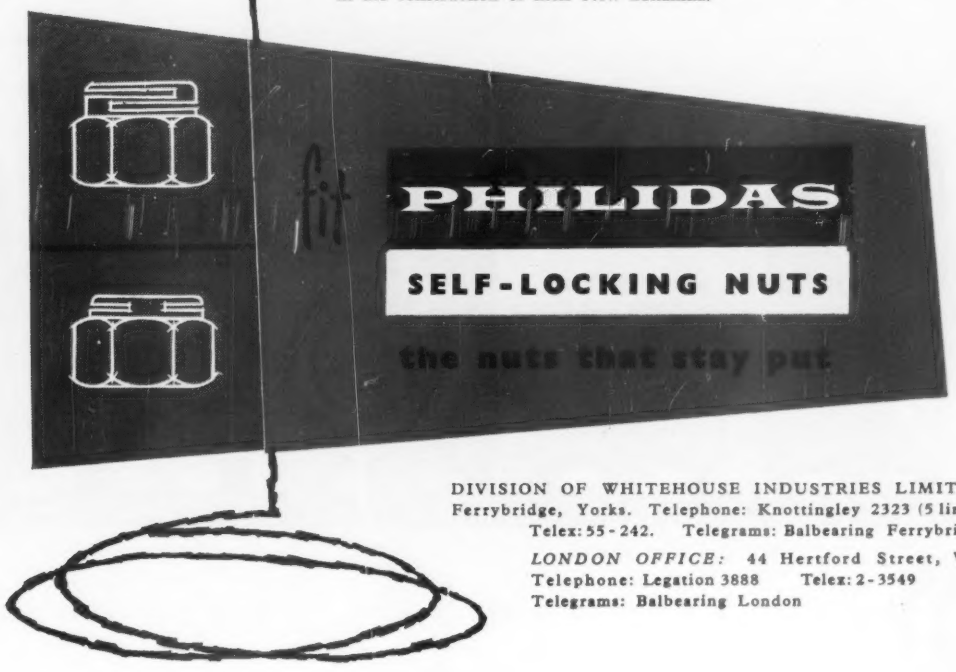

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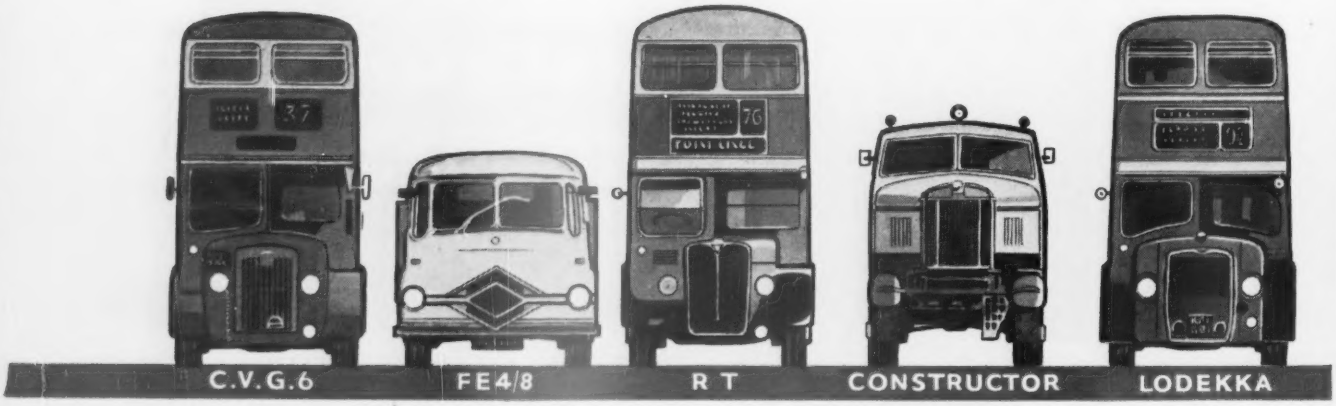

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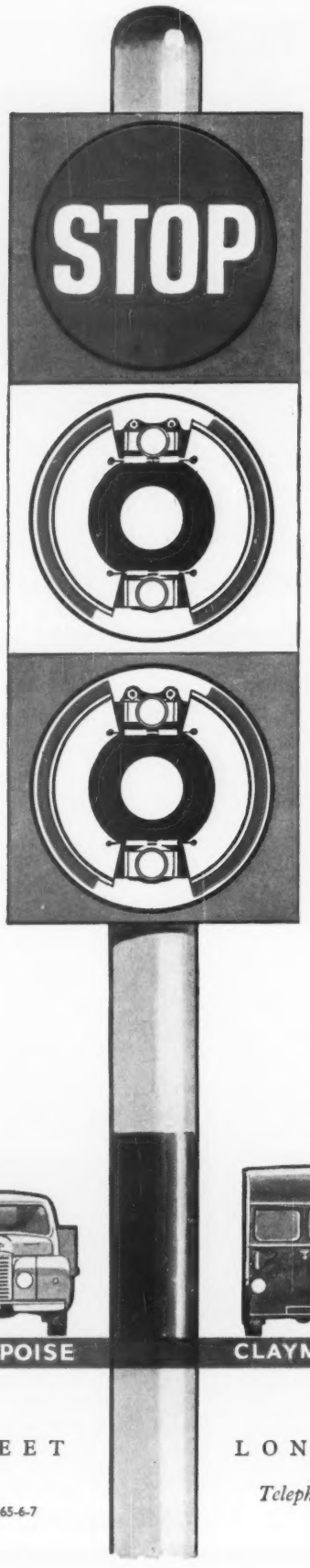

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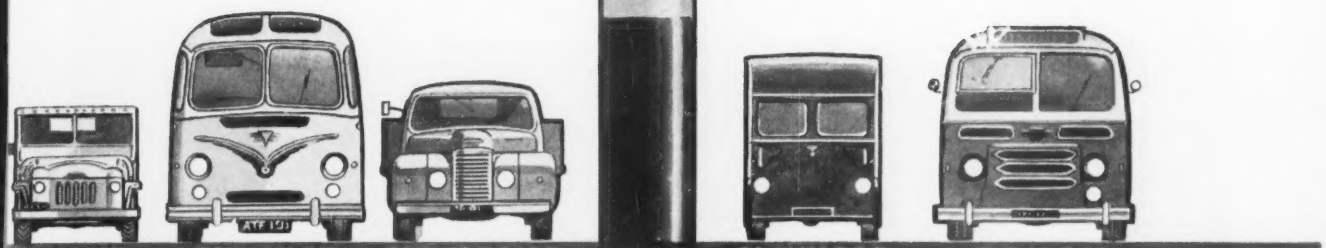

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KE 637 can be machined quite readily. For gauges and tools of intricate shape where final grinding is not permissible KE 637 is an ideal steel for hardening with minimum distortion.

AN OIL HARDENING TOOL STEEL WITH DEEP HARDENING PROPERTIES AND EXTRA WEAR RESISTANCE

KE 595 is more highly alloyed than KE 672 and KE 637 and is capable of wider application. The Steel can be deep hardened in comparatively large sections and is suitable for presswork involving greater tool mass. Excellent torsional properties in the hardened and tempered state make KE 595 an excellent Steel for Taps, Reamers, etc. Also used as tabletting punches and dies for the less abrasive compounds. KE 595 can be heat treated with a minimum of movement.

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We make many other types of Tool Steel for various applications. If further details are required we shall be pleased to arrange for one of our local Technical Representatives to call or we will send you a copy of our booklet " K.E. High Grade Tool Steels for Cold Work ". All our Tool Steels are despatched in the annealed condition, a process which is very carefully controlled as regards time, temperature and atmosphere, to give optimum machinability.

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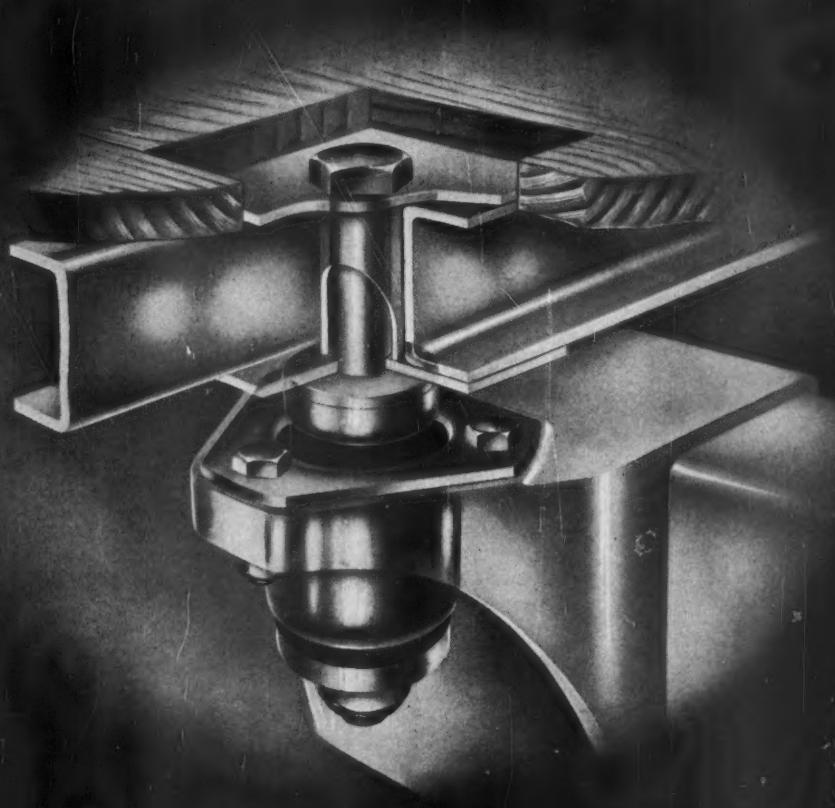

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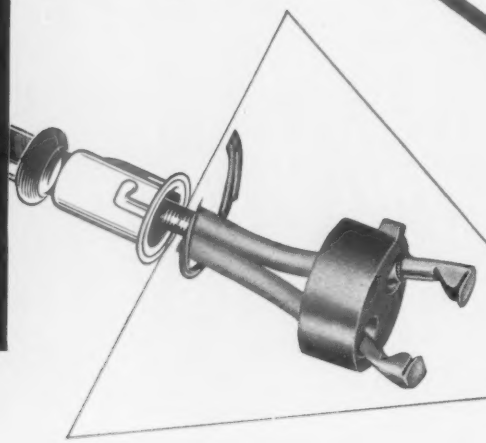

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The inside Story!

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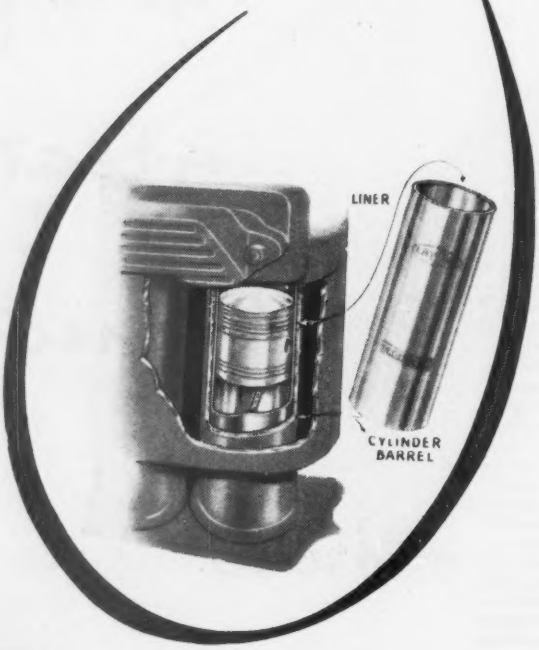
Cromard liners are available for Austin, Albion, Bedford, Commer, Dennis, Dodge, Ford, Land-Rover, Leyland, Morris, Perkins, S.D. Freighter, Thornycroft, and many others.

Service departments of certain manufacturers are becoming more and more Cromard-minded and are now making these liners available.

The long distance motorist too can profit by the experience of the Fleet Operator and is catered for by over 120 Stockists in the United Kingdom alone.



Prices (Southern Confectioners) Ltd. vehicle fitted with Cromard liners.

It is significant that the overseas demand for Cromard liners is ever increasing—especially where operating conditions are difficult, for example, Australia, New Zealand, Malaya, the Rhodesias and South Africa.

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. . . for applications where a sustained and uniform load is to be applied.

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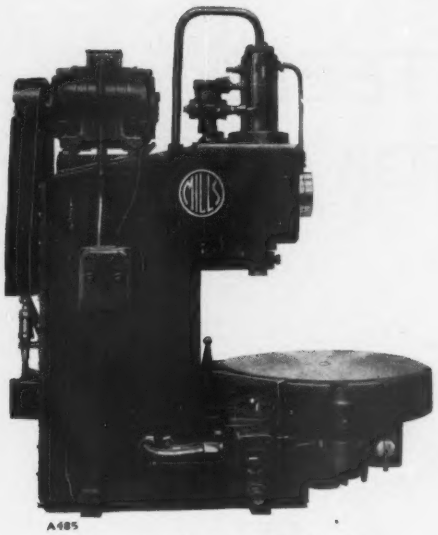
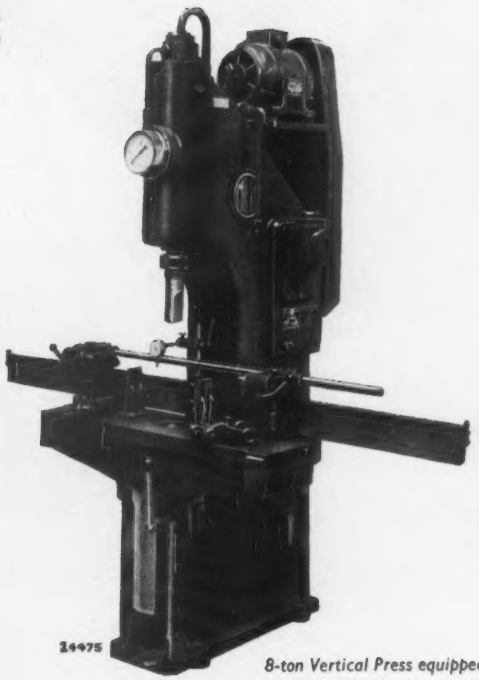
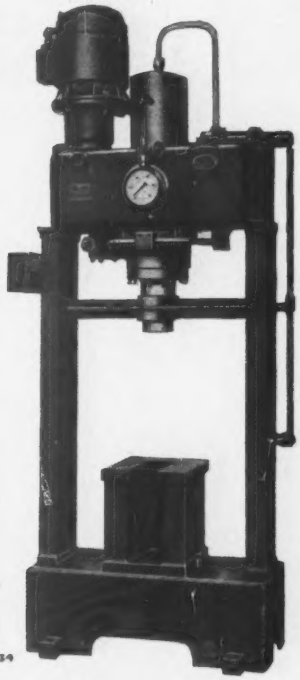
STRAIGHTENING, BENDING, ASSEMBLING, DRIVING and WITHDRAWING ARBORS, GENERAL FITTING, PUSH BROACHING, SQUEEZE RIVETING, COINING, MARKING, PIERCING and PRESSING.



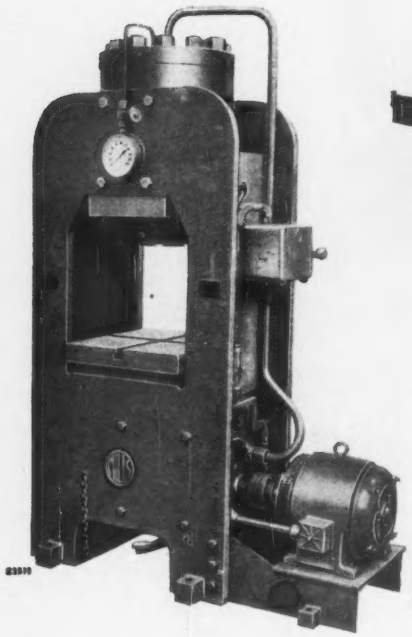
6-ton Bench Press fitted with a 24" dia. hydraulically-operated indexing table.



8-ton Vertical Press equipped for straightening operations.



30-ton Forcing Press for various assembly operations.



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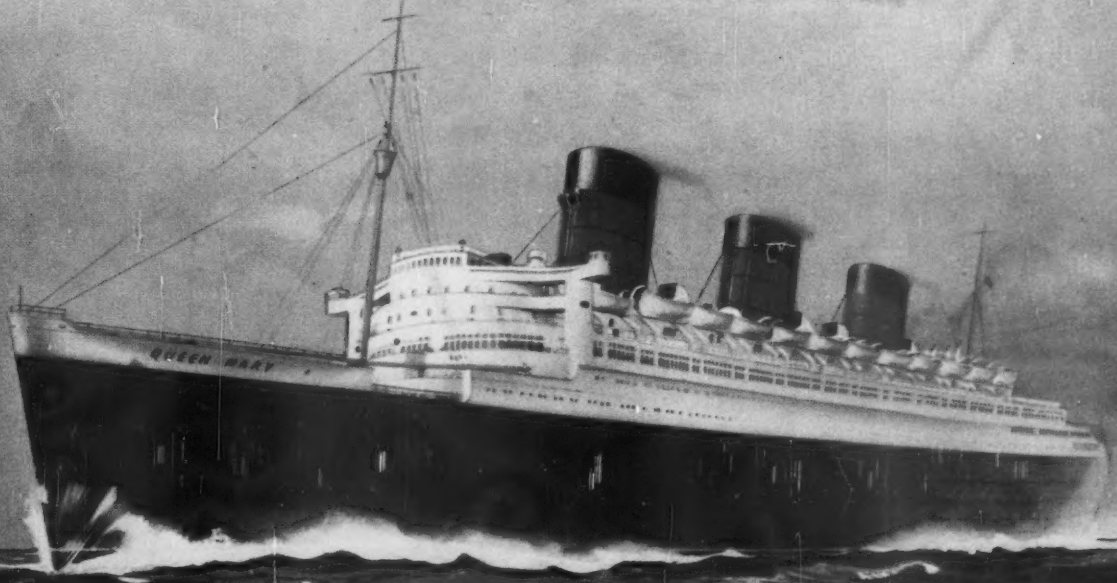

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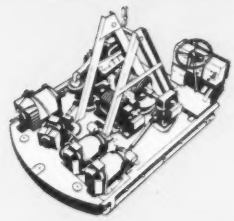
Always on hand to solve the numerous lifting problems that crop up in any factory, Coles have many saving ways.



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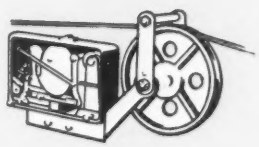

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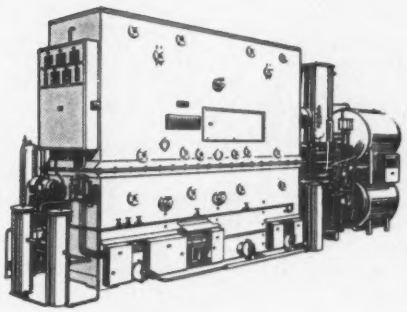

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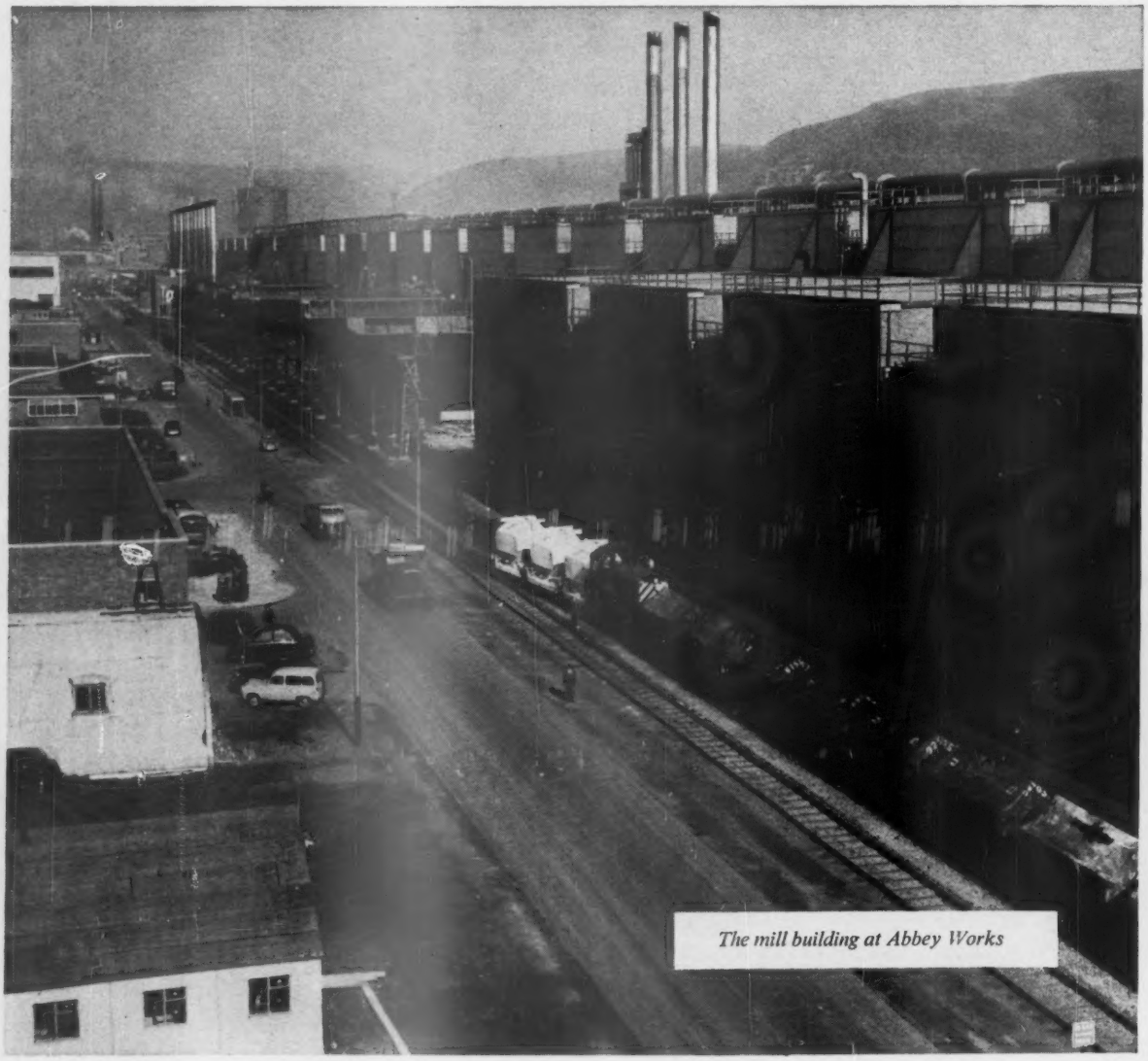
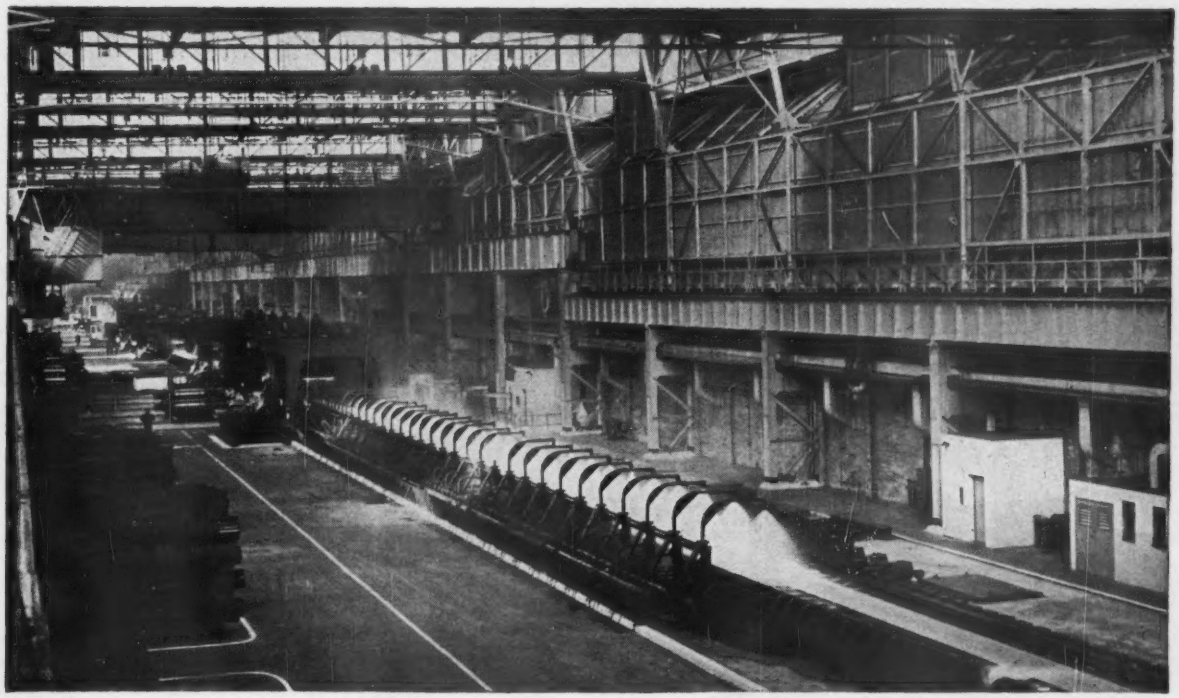


The mill building at Abbey Works



The 80" continuous strip mill at Abbey Works

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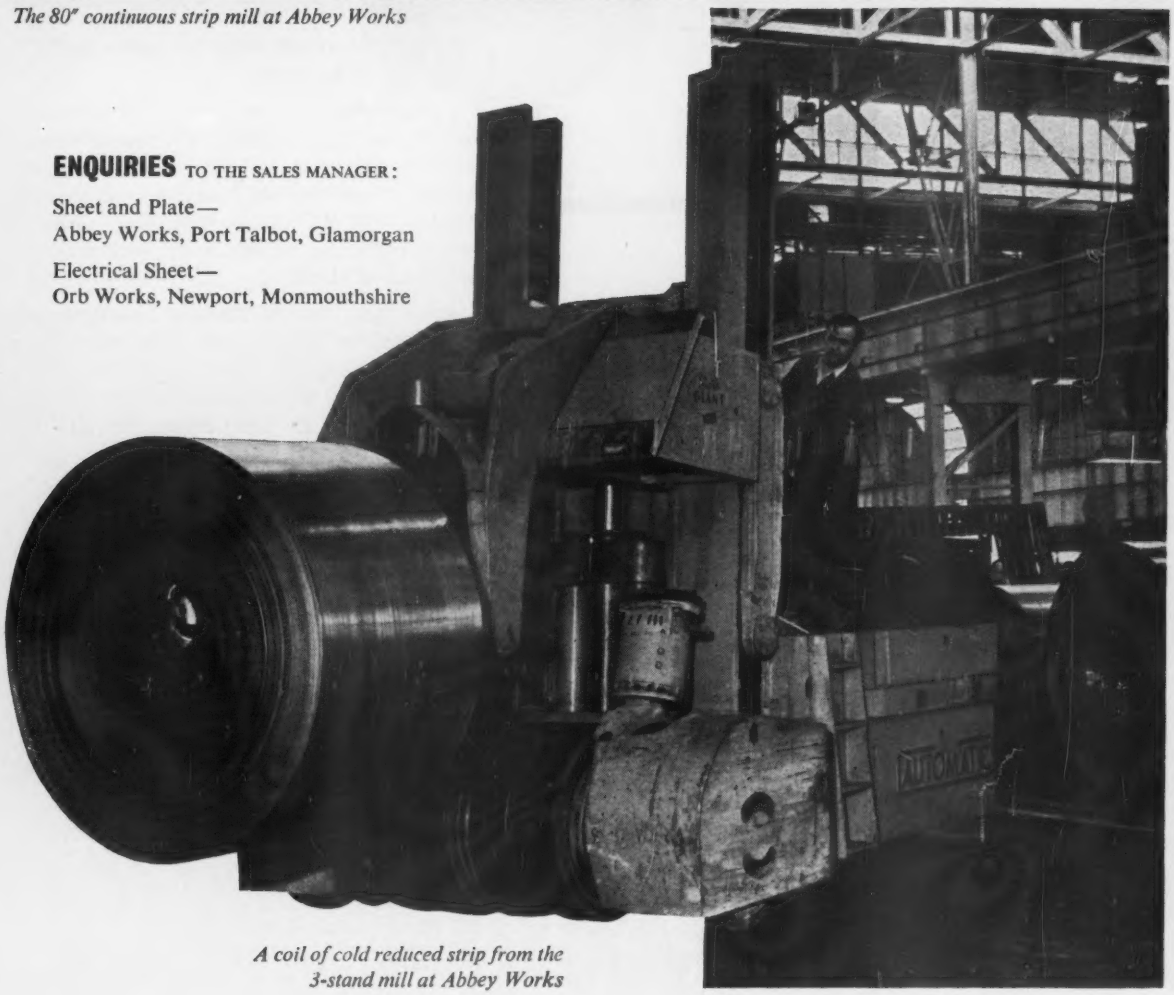

A coil of cold reduced strip from the 3-stand mill at Abbey Works

Keep it off the floor!

In the production line of a factory every component has a value which increases as it passes through each process. But while it's lying about idle, waiting to be moved by hand from one place to another, its cost starts to catch up with its value until it ceases to be an asset.

Components must be kept on the move and off the floor, not by costly and inconvenient manual methods, but by one of the many types of mechanical handling equipment that occupy little or no floor space and can move parts horizontally or vertically to any part of the shop.

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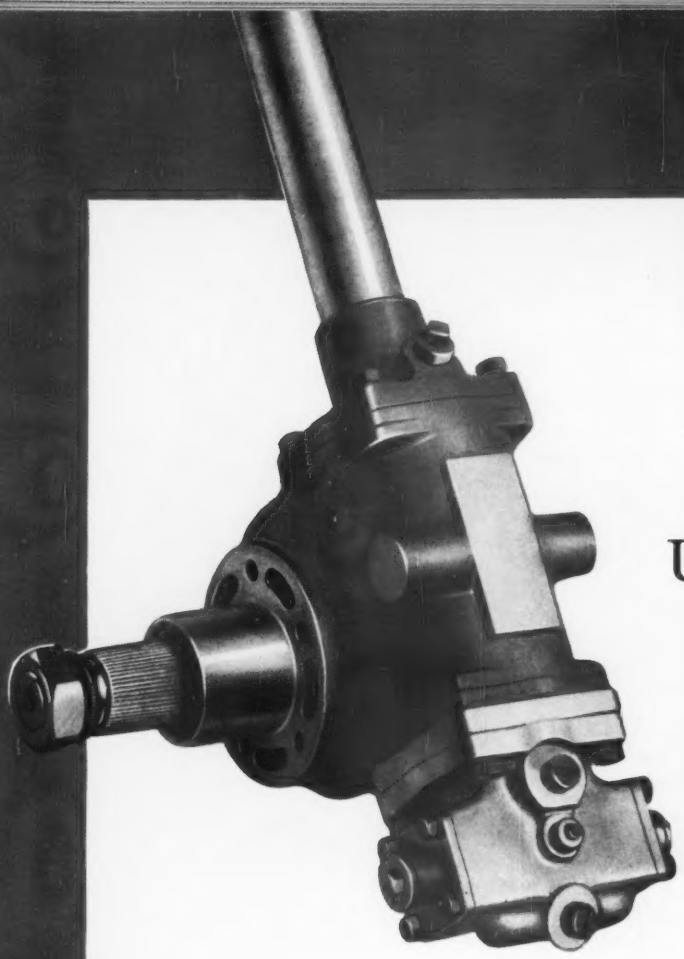

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Illustrated above is the Type 3 'Universal' steering gear which incorporates the hydraulic control valves mounted upon our type '861' manual gear. This is for use with a separate power pump and with power cylinders operating on the steering linkage. Further particulars will be sent on request.

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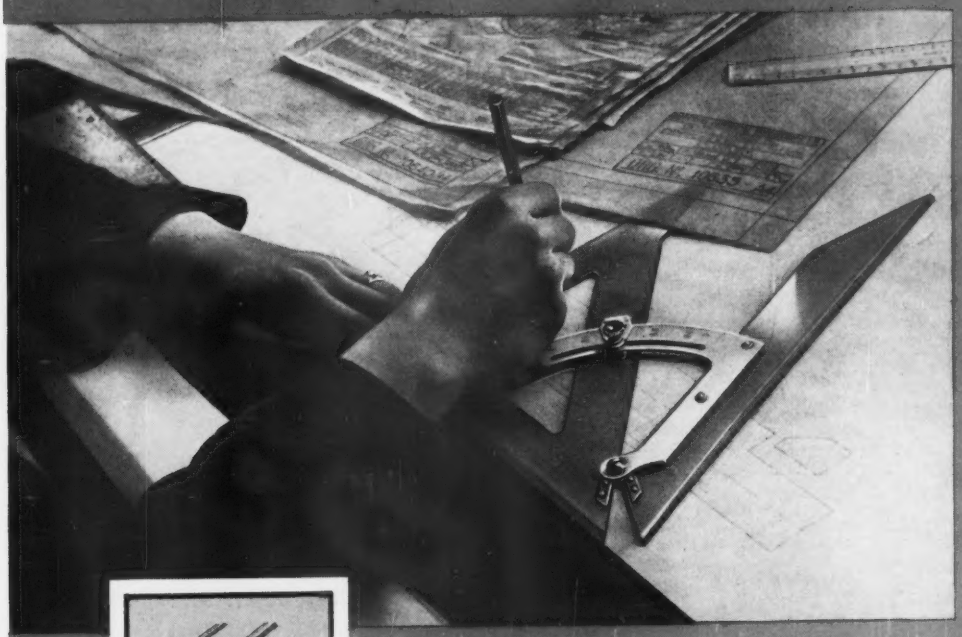
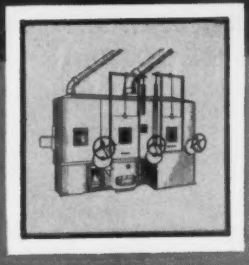
. . . lies behind every recommendation made by the 'Cassel' Heat-treatment Service. A complete range of salts and salt-bath furnaces is manufactured to meet a wide variety of heat-treatment problems.





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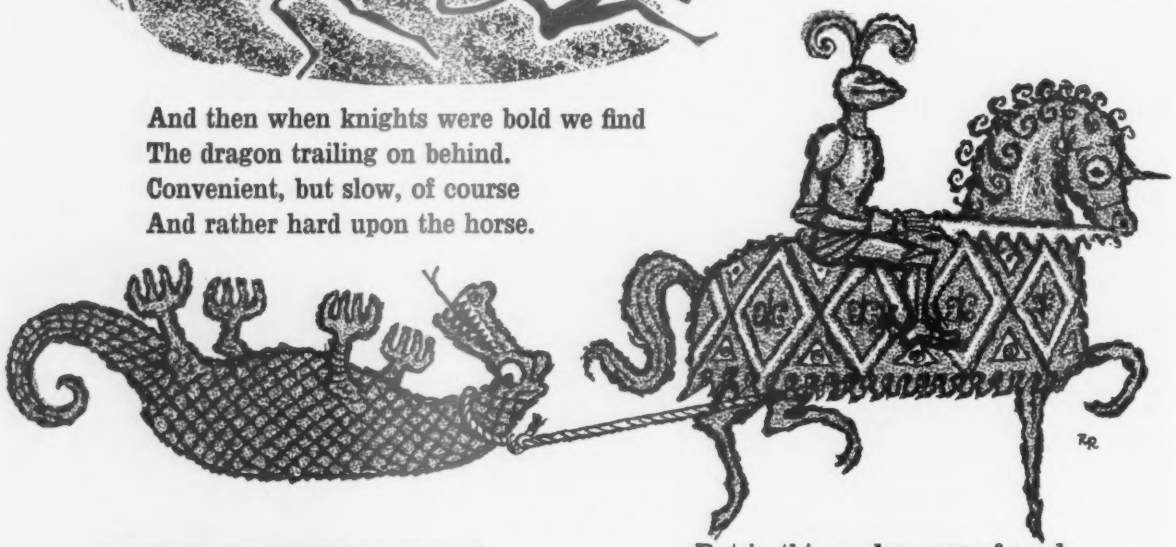
CC. 181

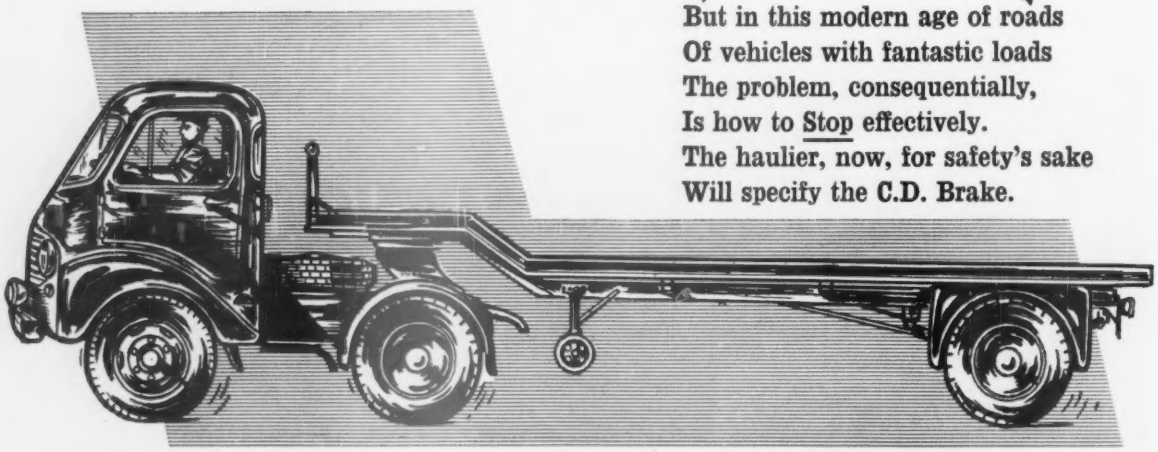
It's a different story now...

In prehistoric days, we feel
Before the advent of the wheel,
Our ancestor in nuptial bliss
Would drag his mate about like this.

And then when knights were bold we find
The dragon trailing on behind.
Convenient, but slow, of course
And rather hard upon the horse.



But in this modern age of roads
Of vehicles with fantastic loads
The problem, consequentially,
Is how to Stop effectively.
The haulier, now, for safety's sake
Will specify the C.D. Brake.



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That's a good reason for having a word with LEE if the products you manufacture call for Steel Strip, Bars or Wire.

As it pays *us* to produce only materials of the highest quality and consistency, so it will pay *you* to use them because of the added prestige and sales they will bring you. *Write or 'phone now.*

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SPIRAL SIDE AND FACE CUTTERS

Cutting time means economy...

Clarkson Spiral Side and Face Cutters operate at higher speeds than standard cutters. One customer claims to have reduced his machining time from 45 minutes to 27 minutes, cutting a nickel chrome steel.

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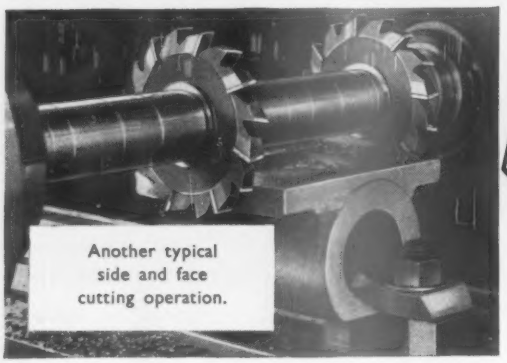

Another typical side and face cutting operation.

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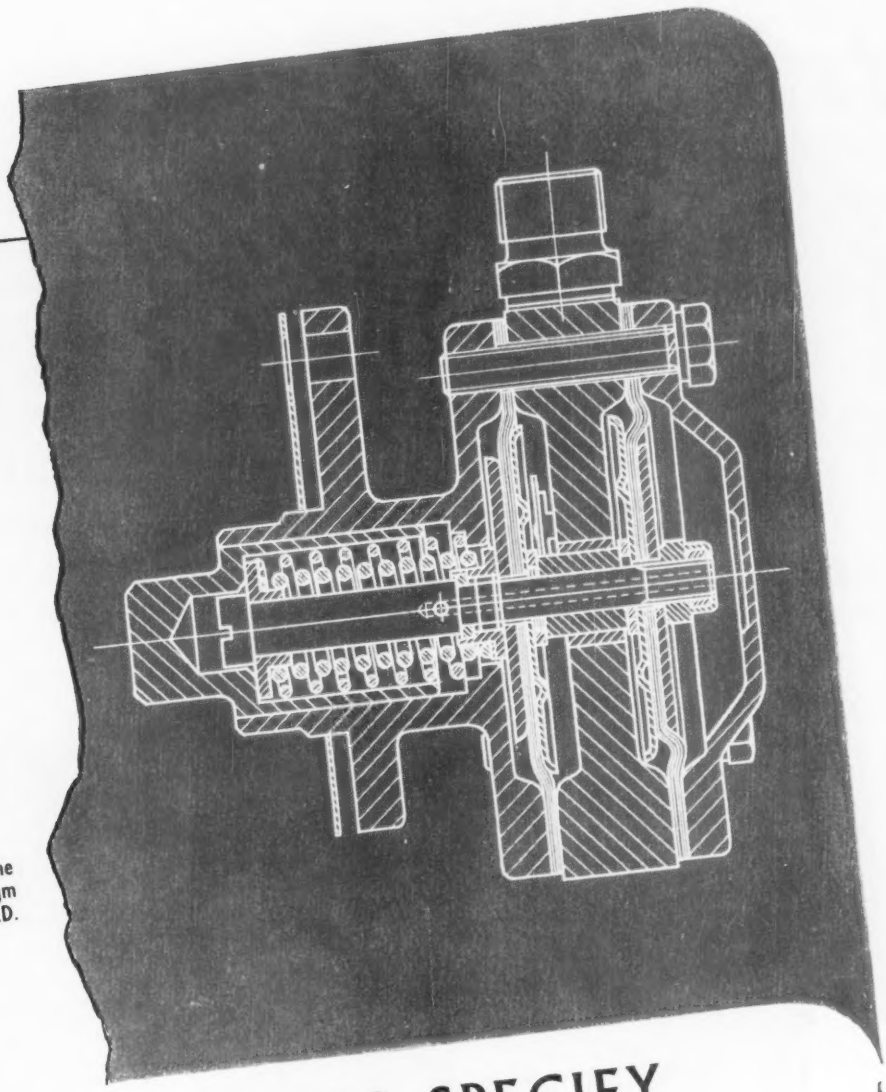

A sectional view of the Simms Double Diaphragm Feed Pump — type PLD.

WHY USERS SPECIFY

Simms

On high powered 6 and 8 cylinder Diesel engines up to 250 BHP, it is essential to have a feed pump which gives adequate fuel delivery. Consider these factors for the Simms PLD feed pump:

1. High output — up to 4 cubic centimetres at 1,000 RPM a stroke,
2. Double acting — for adequate output,
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4. Double diaphragm (2 banks of 4 diaphragms) — for strength,
5. Maximum fuel pressure automatically controlled — for steady delivery.

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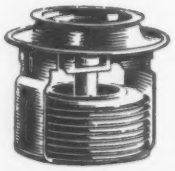
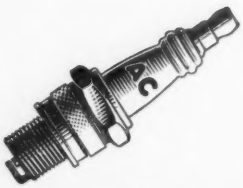
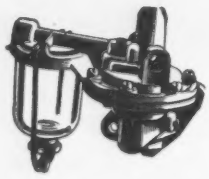


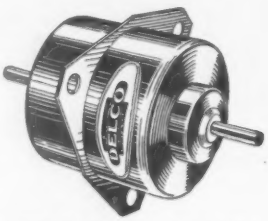
AC THERMOSTATS



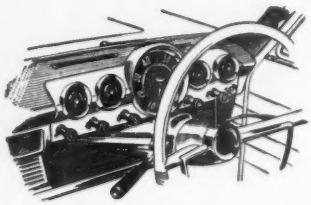
AC SPARK PLUGS



AC FUEL PUMPS

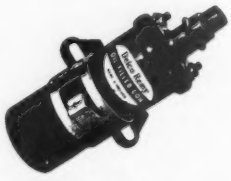


DELCO ELECTRIC MOTORS



AC INSTRUMENTS

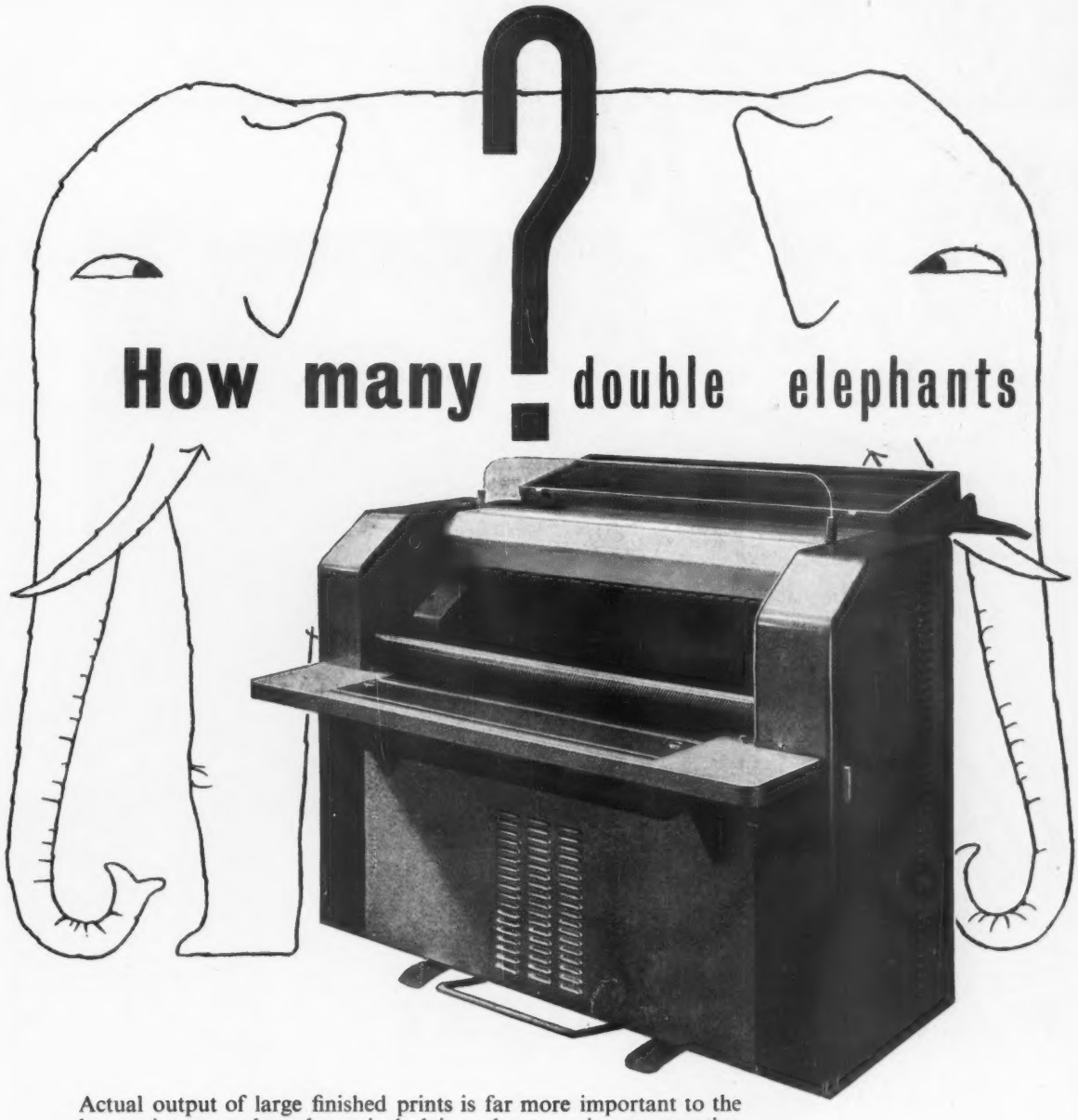
Virtually every British car has one or more AC-Delco components designed into it on the drawing-board. AC-Delco research engineers will gladly help when you are planning a new design or modifying an existing one. Liaison at the drawing-board stage can help your design and production programme.



DELCO-REMY IGNITION COILS

These are a few in the wide range of AC-Delco automobile and electrical products.

AC-DELCO DIVISION OF GENERAL MOTORS LIMITED, Dunstable, Beds. Telephone Dunstable 1166
or Broadgate House, Coventry. Telephone Coventry 40491



Actual output of large finished prints is far more important to the busy print room than theoretical claims about maximum operating speeds. Viewed from this angle, the performance of the AZOFLEX Model 46/35 Combine Printing and Developing Machine is altogether outstanding, for it is capable of turning out prints at a rate well in excess of 1,000 Double Elephants a day, year in and year out. Exposure, development and print delivery are all synchronised for an even flow of finished work and optimum quality is always ensured because Azoflex is the only photo-printing process to apply the correct quantity of developer, irrespective of running speed. In addition, the process is free from unpleasant fumes and requires no complicated ventilating system.

For use with the Model 46/35 and other machines in the Azoflex range, there is a wide choice of high-quality Azoflex materials designed to meet every photo-printing requirement.

AZOFLEX MODEL 46/35

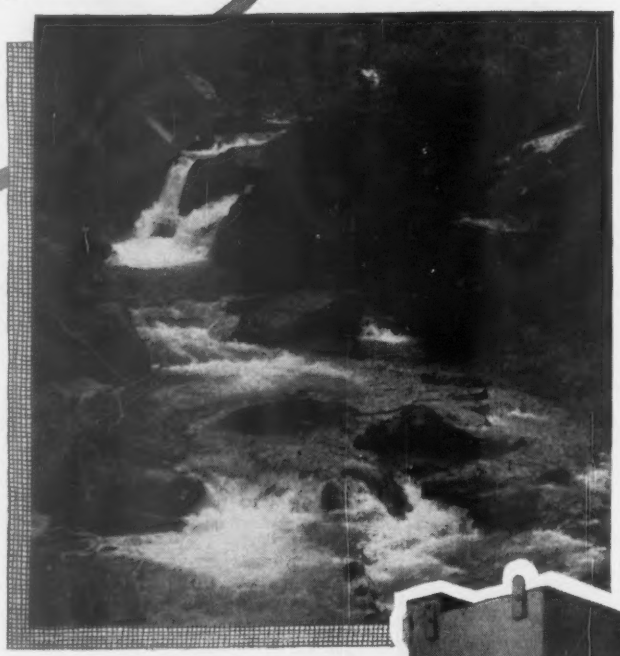
Synchronised printing and developing machine. Capacity: cut sheets and rolls up to 42 in wide. Printing speed: from 2 ft. to 30 ft. per minute. Dimensions: height 58 in., depth 60 in., width 72 in. Weight 1,100 lb. Price £1,555 including delivery and installation in the U.K.

Enquiries to:
Ilford Limited,
Azoflex Sales Department, AZ7C,
104 High Holborn, London, W.C.1
Telephone: HOLborn 3401

ILFORD *Azoflex*

PHOTO-PRINTING MACHINES AND MATERIALS

Save Water



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HEENAN
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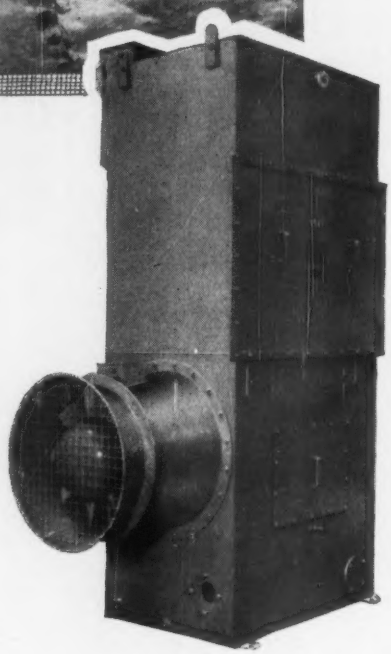

In any process in which heat must be removed by water, very attractive financial savings can be secured by continuously re-cooling and re-circulating the water.

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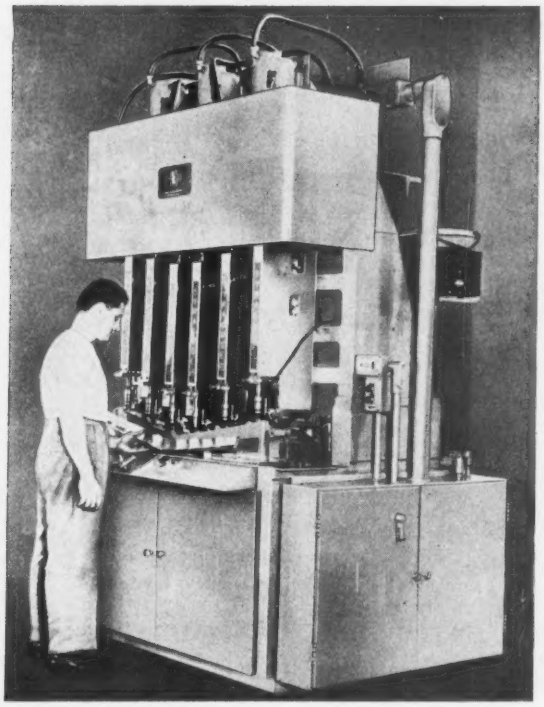
AUTOMATION

SYRACUSE SPECIAL AUTOMATIC STUD DRIVER



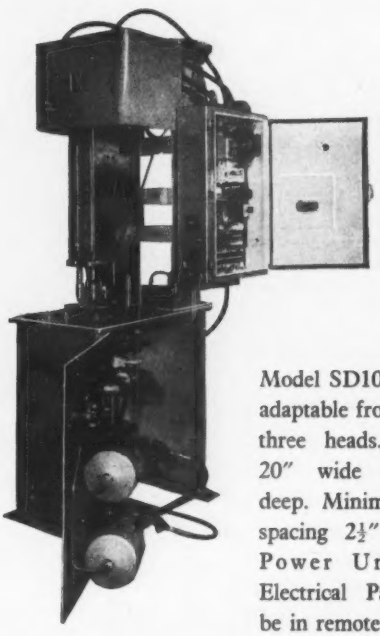
Model SD10-12 Stud Driving Machine, driving from one to twelve studs simultaneously. Table 60″ by 20″. Minimum head spacing 2½″ centres. Also available Model SD10-6, driving one to six studs simultaneously. Table 36″ by 20″. Minimum head centres 2½″.

All studs started and driven simultaneously,
at any height above table,
any angle up to 30° from vertical.

Setting-up time less than one hour.

Suitable for any production stud driving job.

Design lends itself to conveyor automation.



Model SD10-2, easily adaptable from one to three heads. Table 20″ wide by 30″ deep. Minimum head spacing 2½″ centres. Power Unit and Electrical Panel can be in remote location.

Fuller details, including illustrated literature, readily available.

AUTOMATION LTD.

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PHONE : BATTERSEA 5549.

SG–1

in very good company..

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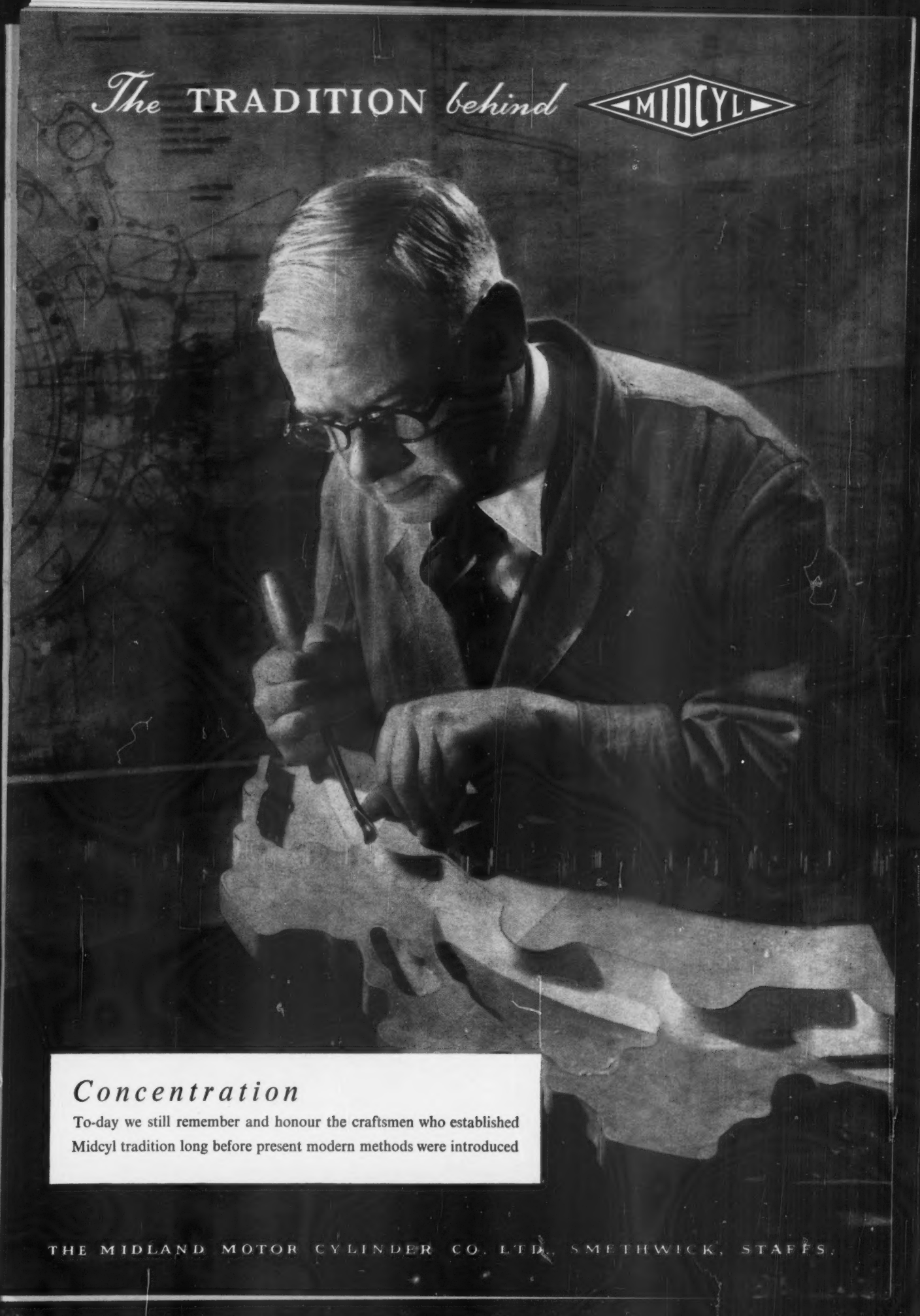

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There is a considerably increased freedom of design when Ley's malleable castings are to be used.

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Shown above is the steering gear box of a heavy commercial vehicle, cast in Ley's 'Black Heart' malleable; note the rigidity of mounting contributed by the integral bracket, attached to the chassis on two faces.

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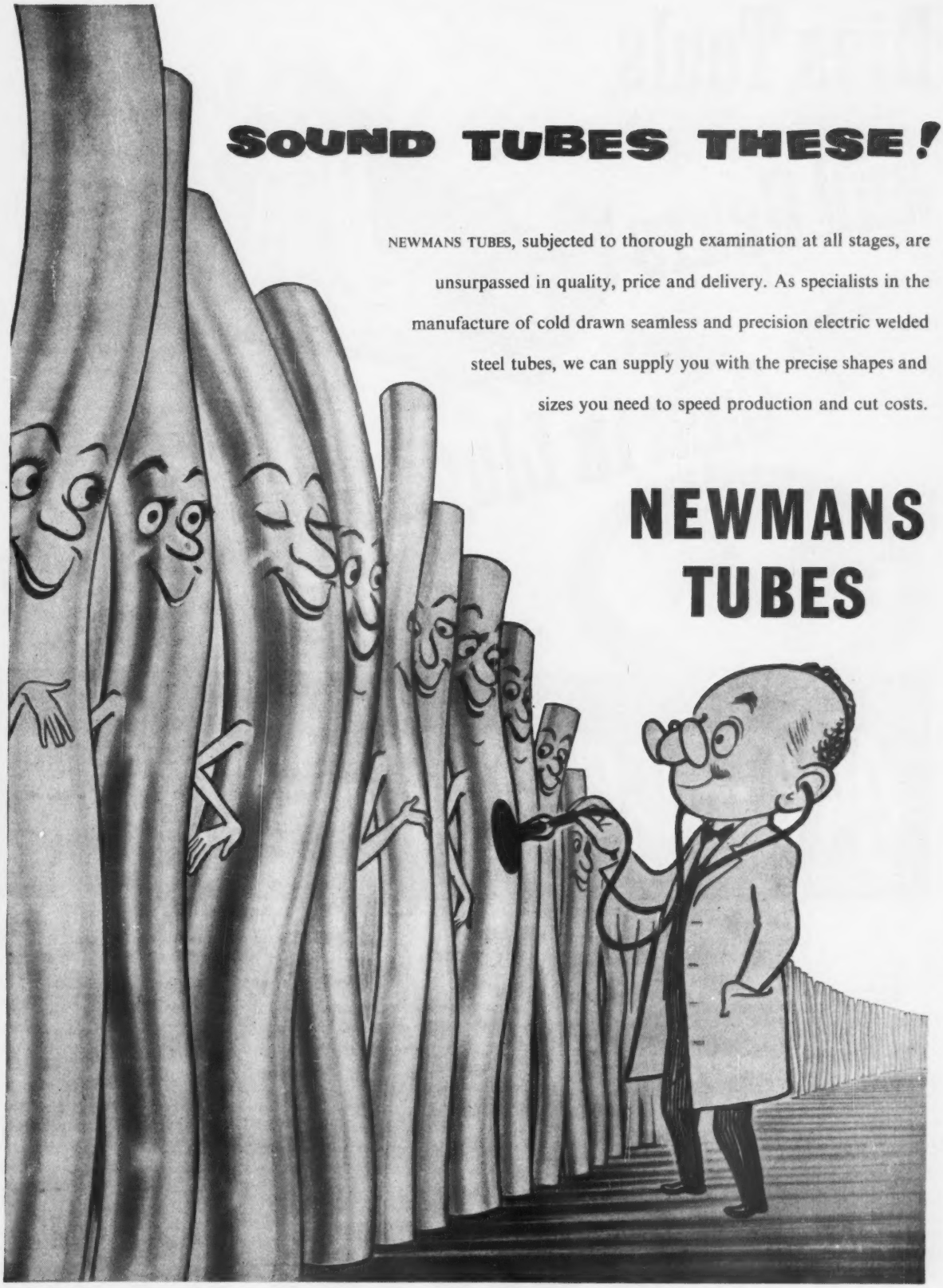

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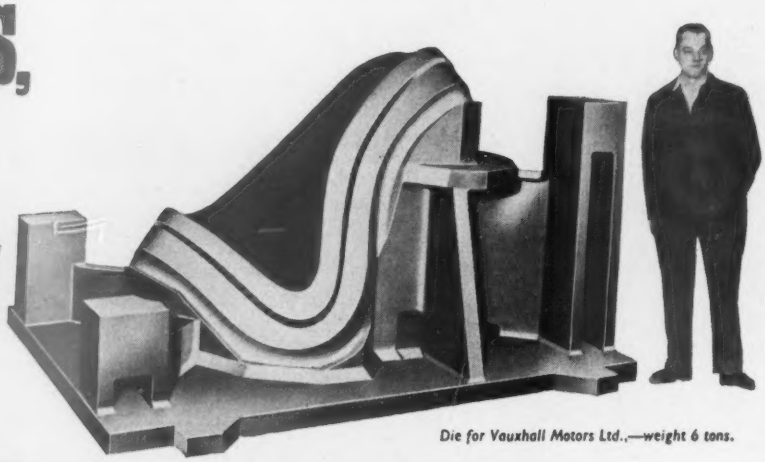

Die for Vauxhall Motors Ltd.,—weight 6 tons.

Cast in Lloyds Ductile Iron

7 ft. diameter Gear Ring

give longer production runs

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Ultimate Tensile Strength	45 t.s.i., minimum	25 t.s.i., minimum
0.5% Permanent Set Stress		15 t.s.i., minimum
Elongation	4% minimum	17% minimum
Izod Impact (0.45" notched)	3 ft. lb. minimum	10 ft. lb. minimum
Brinell Hardness	240/280	140/180

S. G. Iron Specification to British Standard Specification, August 1956.

cost less to maintain

The development of Ductile Iron by Lloyds of Burton provides an efficient new material for designers of dies, tools and gear wheels. Lloyds Ductile Iron combines high mechanical properties with production economies. Whilst retaining the good castability and easy machineability of grey iron, Lloyds Ductile iron gives the tensile strength and resistance to shock of many steels.

Fullest use is now being made of these properties for press shop equipment. For instance, Vauxhall Motors, as a result of experience with Ductile Iron dies in the U.S.A., have specified automobile wing dies of Lloyds Ductile Iron for their Luton press shops (see illustration). Also illustrated is a gear wheel typical of many cast from Lloyds Ductile Iron. The applications of Lloyds Ductile Iron are almost limitless and its properties may well enable you to re-design your present casting for more efficiency and more economy. Technical advice freely given on request

LLOYDS of Burton

LLOYDS (BURTON) LTD., WELLINGTON WORKS, BURTON-ON-TRENT · TELEPHONE: BURTON 3867

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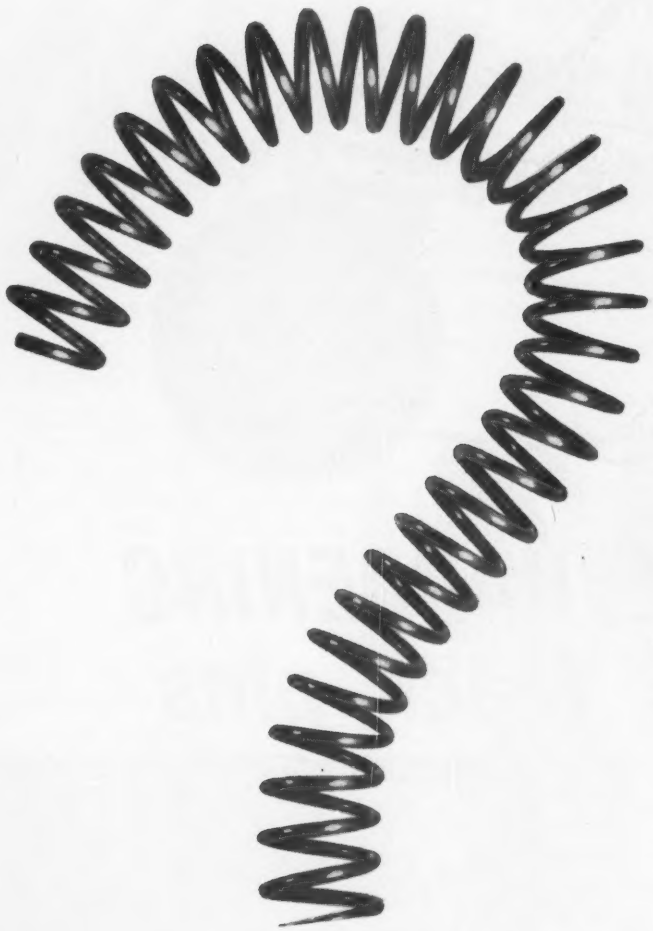

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If so, Terry's BOXES OF ASSORTED SPRINGS are the answer. Here you have a marvellous assortment of Compression and Expansion springs . . . in all varieties, weights, lengths, gauges and diameters. The 9 boxes we show here are only a few from our very wide and varied range. Let us send you a fully illustrated list—post free.

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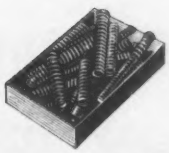
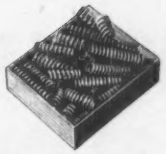
HERBERT TERRY & SONS LIMITED · REDDITCH · WORCS

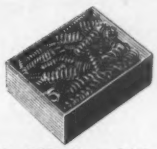
(Makers of fine Springs, Wireforms and Presswork for over a century)



No. 760. 3 doz. Assorted Light Compression Springs 1″ to 4″ long, 22 to 18 S.W.G., ¼″ to ½″ diam. 6/6 each.



No. 98A. 3 doz. Assorted 1″ to 4″ long, ¼″ to ¾″ diam., 19G to 15G. 5/6 each.



No. 757. Extra Light Compression, 1 gross Assorted, ⅛″ to ⅜″, ¾″ to 2″ long, 27 to 20 S.W.G. 15/- each.

No. 388. ½ gross Assorted Small Expansion Springs. ¾″ to 1½″, 18G to 21G. 9/6 each.

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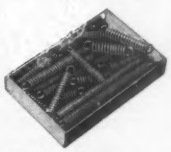
No. 1013. 1 gross Small Coil Compression Springs, ⅜″ to 1½″ long, 3/32″ to 7/16″ diam., 24G to 19G. 6/- each.



No. 753. 3 doz. Assorted Light Expansion ¼″ to ½″ diam., 2″ to 6″ long, 22 to 18 S.W.G. 10/6 each.

Cut Production costs with TERRY Wire Circlips ***(Square Section)***

We can supply from stock in sizes from ⅛″ to ⅞″.

No. 1024. 20 Compression Springs 12″ long, ¼″ to ½″ diam., 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansions 1½″ to 12″ long, 5/32″ to ⅜″ diam., 22G to 16G. 24/- each.

***Interested in Springs? 1957 Editorial Spring Design and Calculation—post free 12/6**

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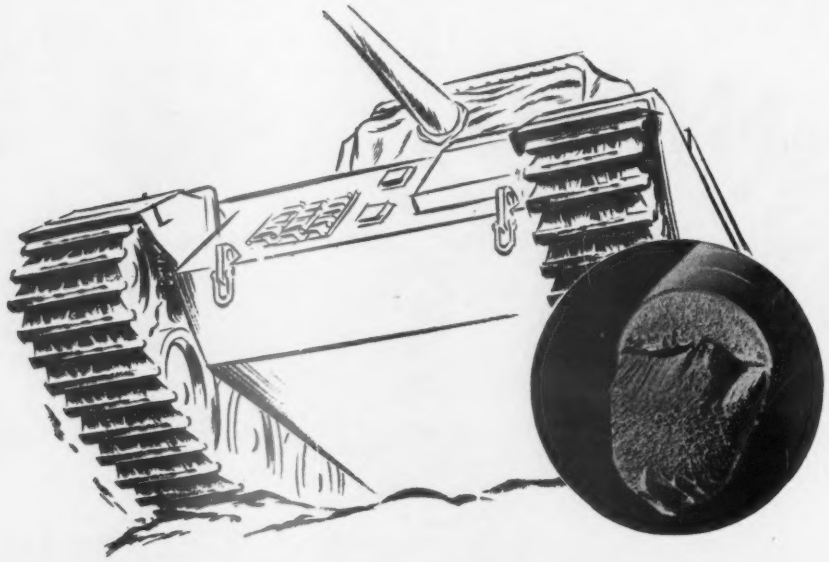

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Tank track pins are being surface hardened with a G.E.C. high frequency induction hardening machine at the Cardiff works of Curran Steels Ltd. The pins are hardened to a minimum of 54 Rockwell C and to depths varying from .025″ to .050″. Previously it was found difficult—and with one pin size impossible—to restrict the hardened surface to acceptable limits and all pins had subsequently to be straightened.

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NEW ANDRE AIR SPRINGS FOR COMMERCIAL AND PASSENGER VEHICLES

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AUTOMATIC LEVELLING

A suspension incorporating Andre Air Springs and levelling valves assures that the floor of the vehicle is always parallel to the axle, thus uneven loading and severe crown road conditions etc. are overcome, giving a more pleasant and easy ride for the driver. For Passenger Vehicles step heights remain constant irrespective of load.

ALWAYS THE SAME RIDE WHETHER LIGHT OR LADEN VEHICLE

A feature of air springing is that, due to the action of the levelling valves, the position on the load deflection graph remains constant irrespective of load; consequently the frequency remains the same for all conditions of service. This also has the effect of eliminating bouncing due to resonance conditions, thus reducing maintenance not only of the suspension but chassis and body. It also affords greater protection for the goods or passengers being carried.

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This ideal suspension gives greater tyre life.

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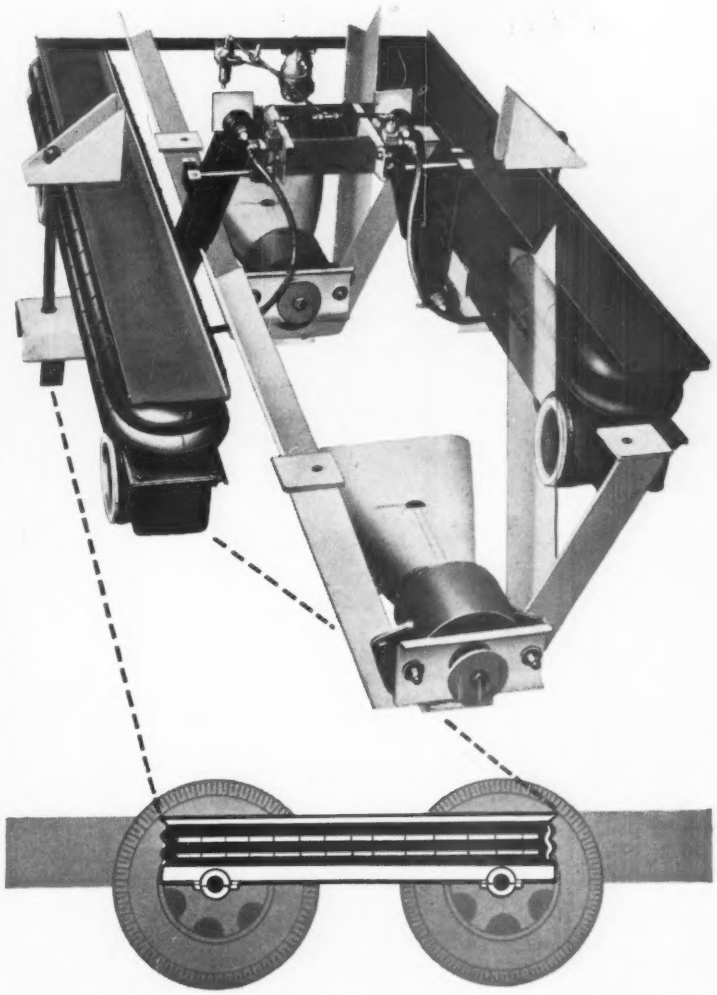

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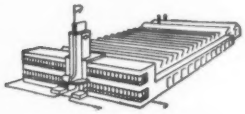

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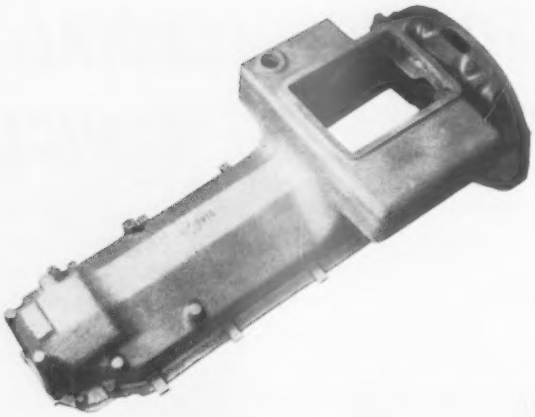
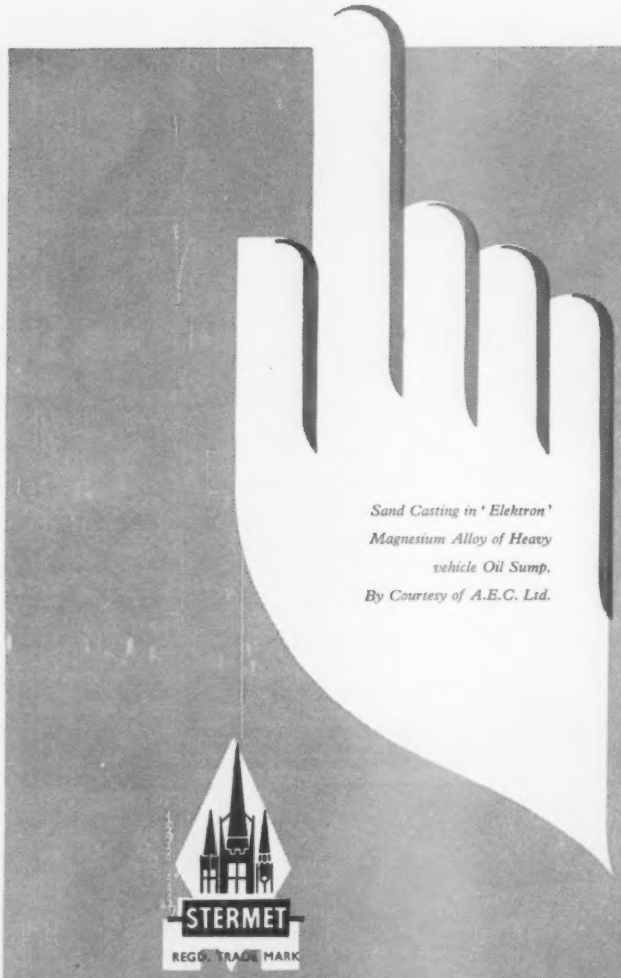


castings by STERMET



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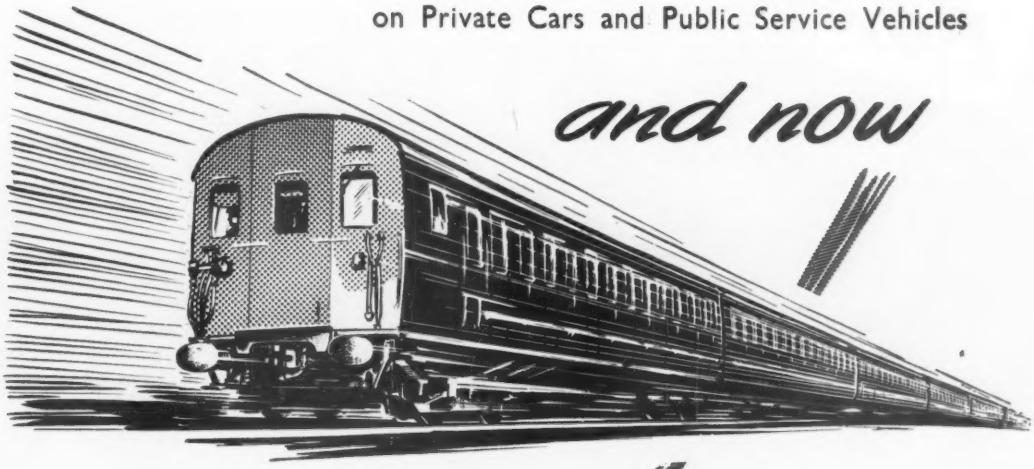

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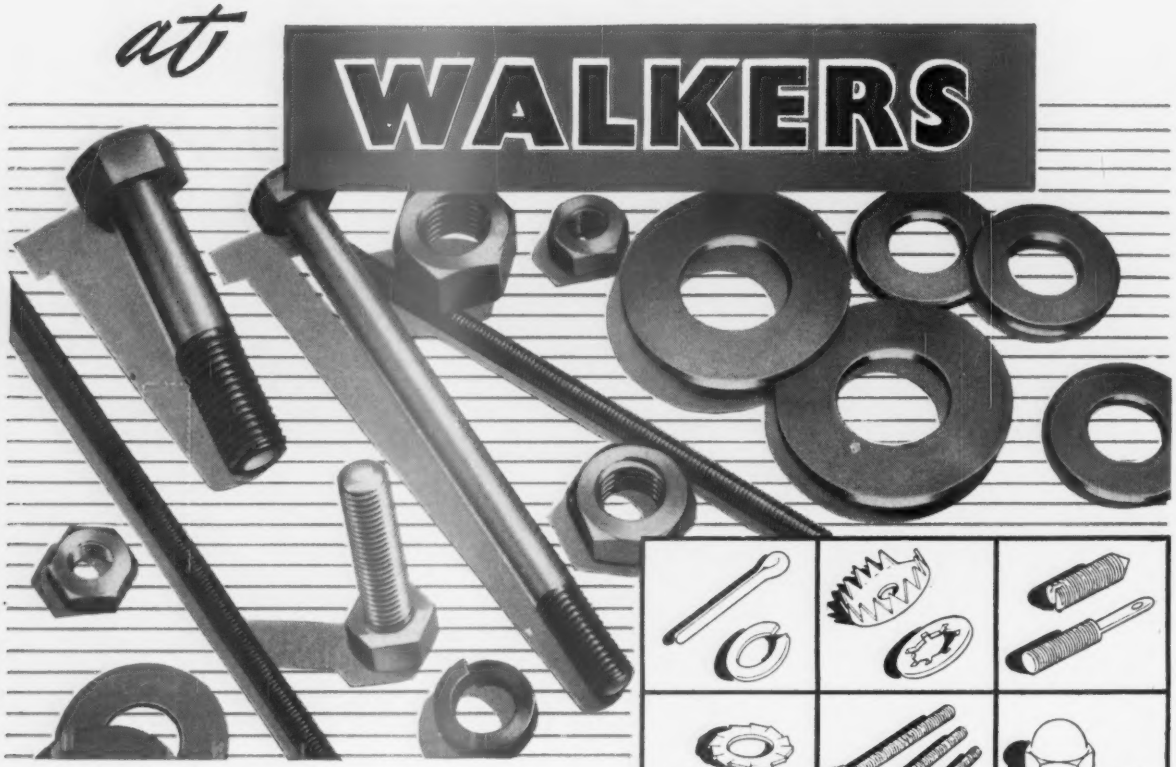

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All three — and much more! 'Fibroceta' can be made as a thick, rigid felt . . . or as light as swansdown.

Is it easy to handle?

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is ready to meet developments
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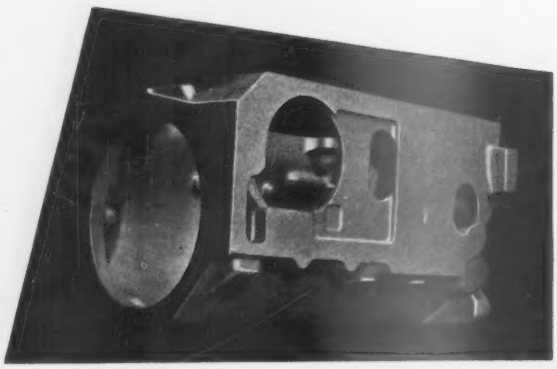
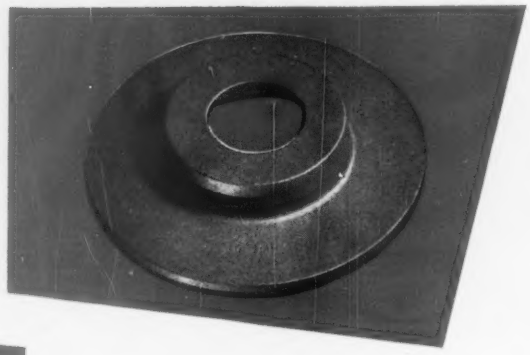


AUTOMATIC GEARBOX CASE *(COURTESY OF ROLLS-ROYCE LTD)*



BRAKE DISC *(COURTESY OF DUNLOP RIM & WHEEL CO LTD)*

COMPOSITE STEEL & CAST IRON BRAKE DRUM
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DARTMOUTH AUTO CASTINGS LIMITED
SPECIALISTS IN HIGH DUTY IRON CASTINGS FOR THE MOTOR INDUSTRY

SMETHWICK 40
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4 blowpipes in 1

with the SAFFIRE COMBINED OUTFIT

The Saffire Combined Outfit introduced by British Oxygen last October met with immediate success and its versatility and efficiency have been proved on every job. The basis of the outfit is a common shank, to which various heads can be fitted for welding, cutting, heating and flame cleaning—virtually *four blowpipes in one*. The Saffire can be purchased for any or all of these applications, or the set can be built up to meet your needs as they occur. Why not ask your local Branch Office for a demonstration and full details?

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BRITISH OXYGEN GASES LIMITED, INDUSTRIAL DIVISION, BRIDGEWATER HOUSE, ST JAMES'S, LONDON, S.W.1

You can have a fully co-ordinated system with standard hydraulic equipment from

Plessey

VALVES

Control valves—spool and poppet, constant flow valves, relief valves.

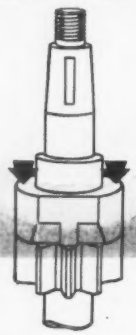
RAMS

A large number of special duty types and a wide range of standard rams—double or single acting and telescopic and variable stroke.

PUMPS

Incorporating special patented pressure-loaded bearings. Flows up to 42 g.p.m. Pressures up to 2,500 lb. at over 90% volumetric efficiency.

When planning hydraulic power for tractors, fork lift trucks, combines or other equipment, an increasing number of design engineers rely on Plessey valves, rams and pumps.



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If you have a problem which involves hydraulic power, get in touch with Plessey—they may well be able to provide the answer — simply, efficiently and economically.

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THE PLESSEY COMPANY LIMITED, RODBOURNE, SWINDON, WILTS

HP10

versatile

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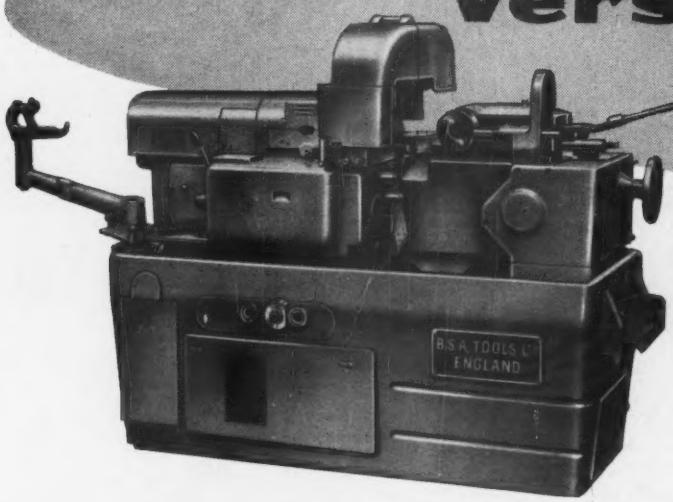
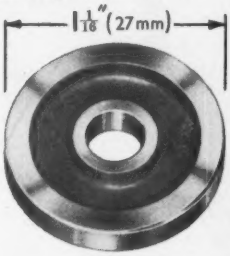


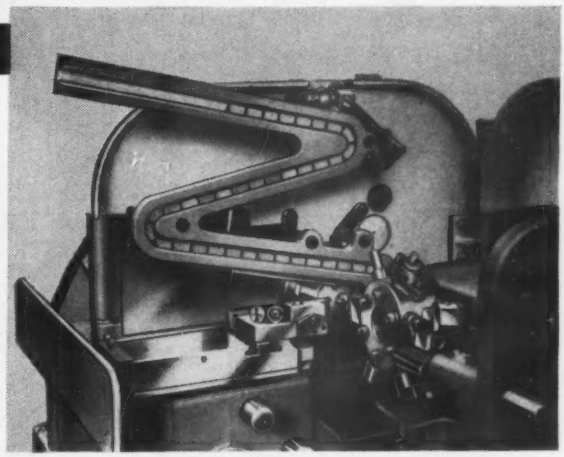
Many problems involved in the high-rate production of work of special nature or requirement are being solved by B.S.A. single spindle automatics. For work up to 2 in. diameter, from the commonplace to the most intricate, B.S.A. automatics maintain their reputation for speed with accuracy and reliability.

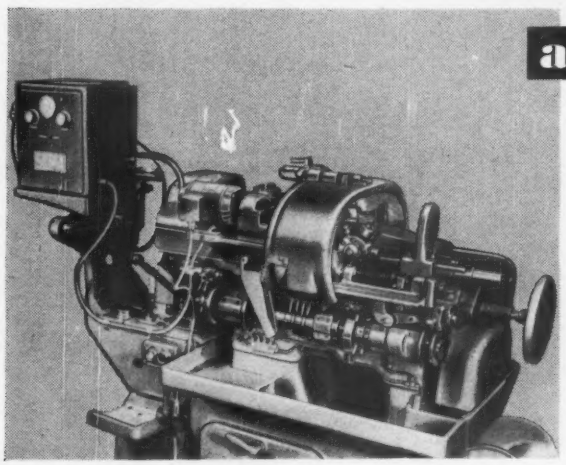
magazine loading

This bronze component is machined complete in 7 seconds on a B.S.A. 98 single spindle automatic. The "hairpin" magazine feeds the cast-blank to a loading block on the rear cross slide whence it is transferred to a chuck. Ten operations are performed involving tooling on the front cross slide, the turret and a stationary cutter within the workspindle, then the finished part is automatically released to fall in the pan.



7 Secs

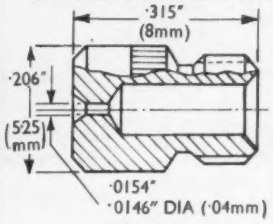




automatic inspection

Standard tooling on a B.S.A. 48 single spindle automatic produces this burner-jet in 3¼ seconds. Included in the sequence of operations is an electro-pneumatic means of automatic inspection of the fine hole. Any obstruction to an air-blast which is directed through the component causes a back pressure to be fed to a Sigma control unit. This operates a solenoid unit which stops the machine and lights an indicator. Drill replacement and removal of the defective component can then be made.

409



3¼ Secs

Also B.S.A. METRIC 18-52 mm. single spindle automatics for users of continental specification machines

B.S.A. TOOLS LIMITED · BIRMINGHAM 33 · ENGLAND

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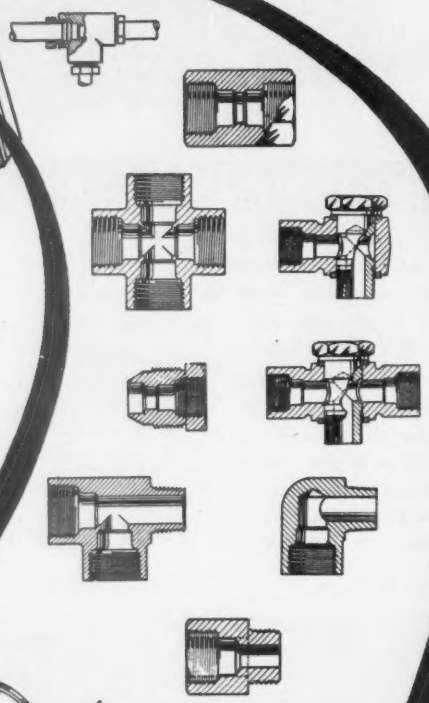
Fitted any good unions lately?



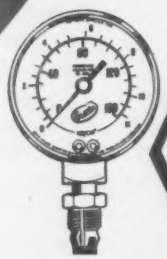
More and more manufacturers are standardizing on Enots brass solderless unions because :

(a) They make a 100% leak proof joint.

(b) Fitting and assembling costs are reduced.

(c) The range of some 700 components caters for outside diameter tube sizes from ¼" to 1½" and for pressures from 4,000 to 1,000 lb. per square inch, according to size.

(d) They are specially suitable for compressed air and hydraulic circuits.



Enots standard pressure gauge (0-160 lb. per sq. inch) fitted with solderless nut and sleeve which enables gauge to be tightened into position and facing in any required direction without all the usual troubles always experienced when the gauge is screwed.

Enots

SOLDERLESS UNIONS

We invite you to send for our catalogue SF854 which also includes details of copper, Bundy steel and flexible tubing.

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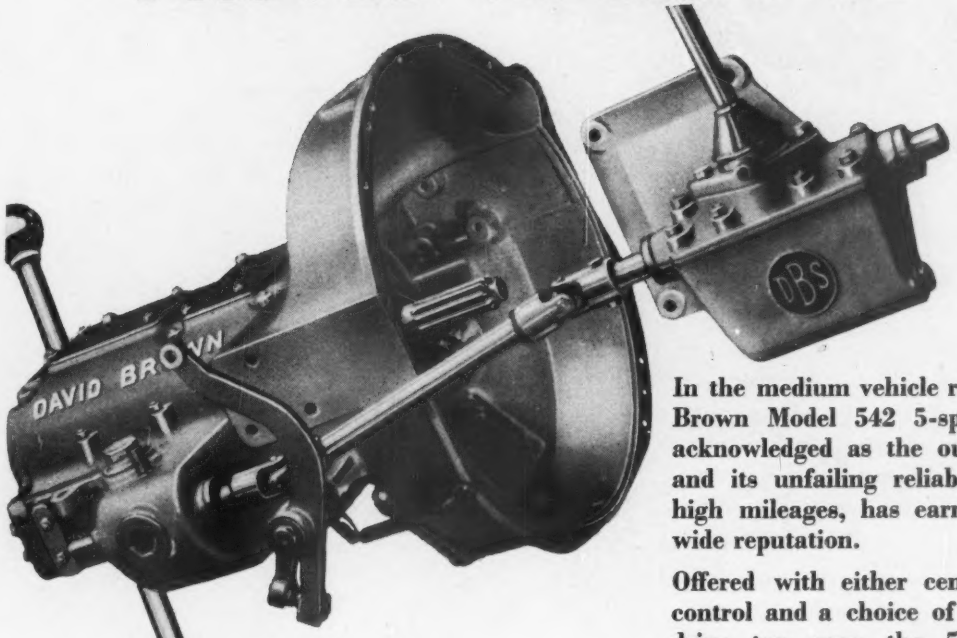
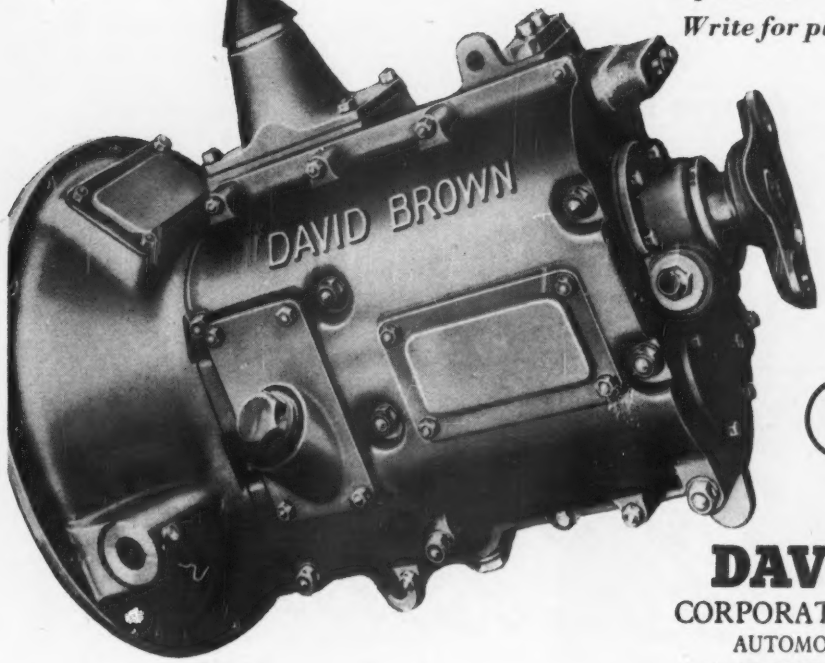
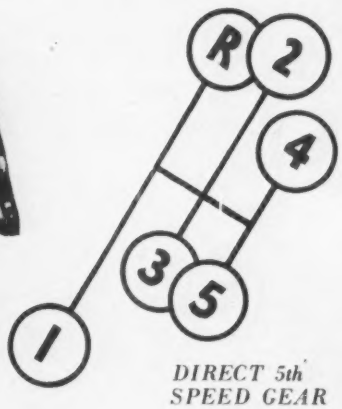


In the medium vehicle range, the David Brown Model 542 5-speed gearbox is acknowledged as the outstanding unit, and its unfailing reliability, over very high mileages, has earned it a world-wide reputation.

Offered with either centre or forward control and a choice of direct or over-drive top gear, the 542 gearbox is designed for a maximum torque of 205 lb/ft. and is characterised by its sturdiness, compactness, low weight to strength ratio, ease and quietness of operation.

Write for publications E393.26 and 27





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THE
DAVID BROWN
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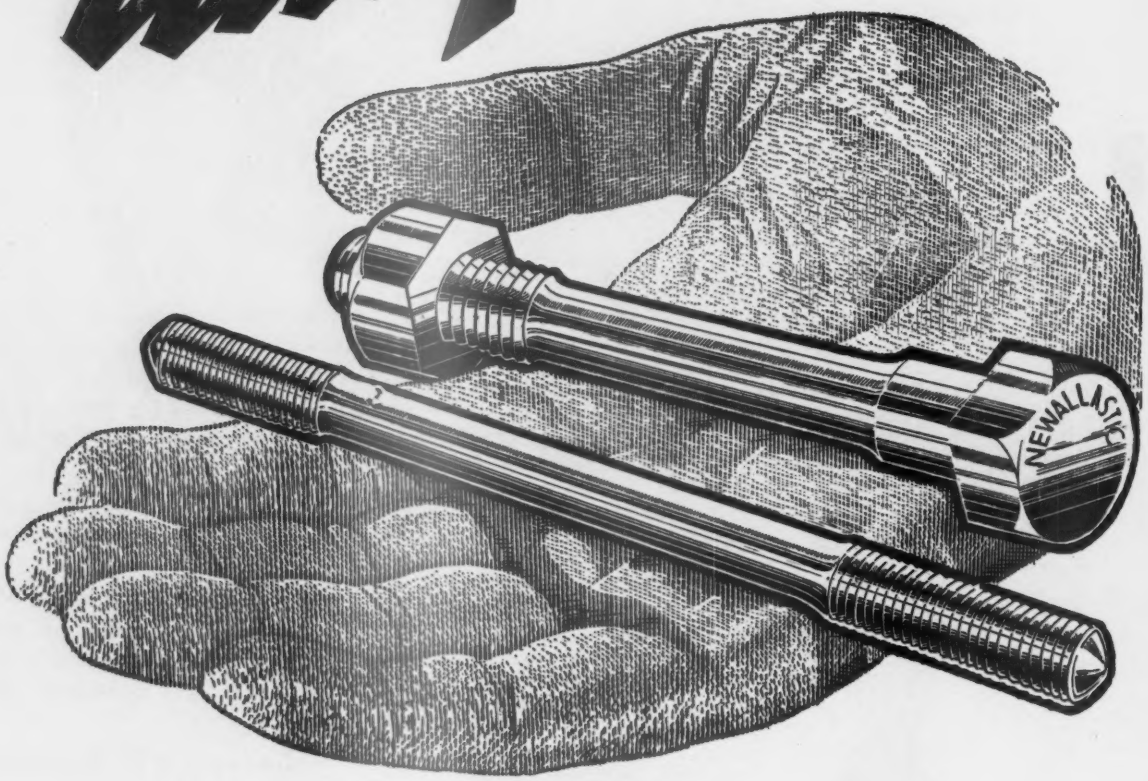
Unique



"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

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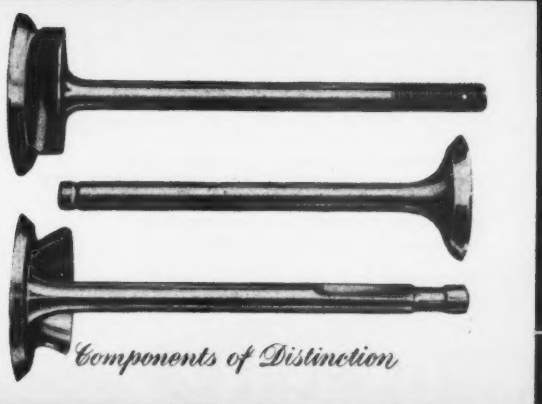
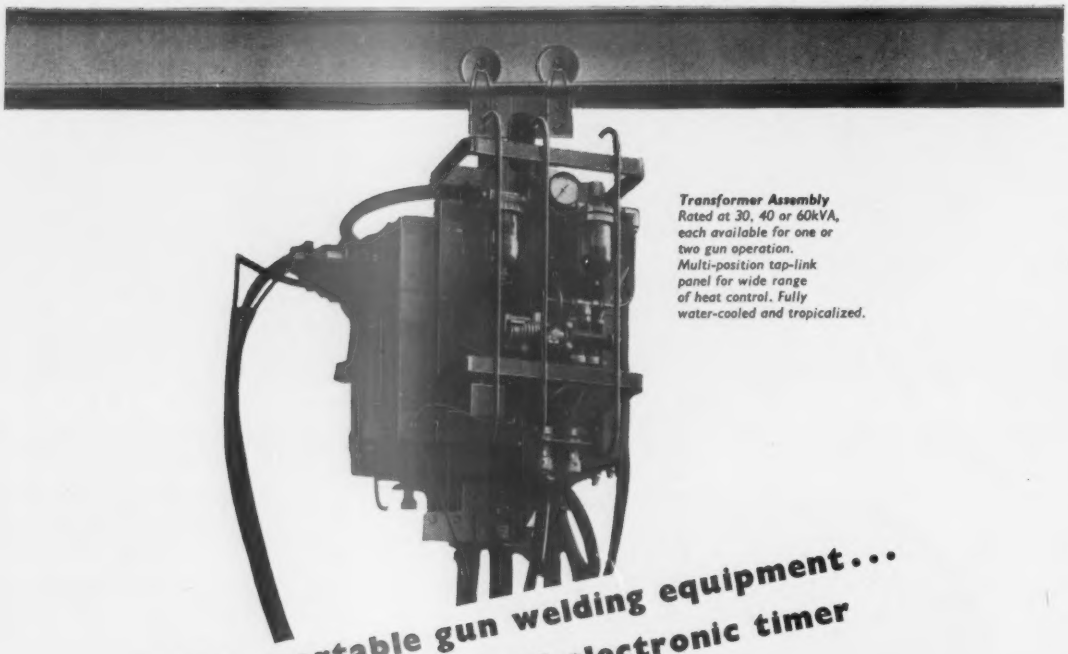


Components of Distinction



Transformer Assembly *Rated at 30, 40 or 60kVA, each available for one or two gun operation. Multi-position tap-link panel for wide range of heat control. Fully water-cooled and tropicalized.*

Philips portable gun welding equipment... ignitron contactor and electronic timer

- *Reduced operator fatigue*
- *Controls conveniently grouped*
- *For one or two gun operation*
- *Standard components interchangeable with Philips spot/projection welders*

Contactor/Timer Unit *— for wall mounting. Ignitron contactor and four-function timer for automatic control of complete welding sequence. Available with duplicate timers for independent double-gun operation. Size: 30" x 30" x 10" deep.*

In this new Philips equipment, the weight of the transformer assembly has been reduced by the use of a wall-mounted ignitron contactor/timer unit. The transformer — which can be suspended from an overhead trolley or rail — is designed primarily for use with Philips air-operated, single-acting spring return guns, or double-acting air return type. The equipment has applications wherever spot welding assemblies are too large to be accommodated in pedestal type machines.

Write for leaflet PI.4869 which gives full technical details.

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PHILIPS ELECTRICAL LTD

INDUSTRIAL PRODUCTS DIVISION

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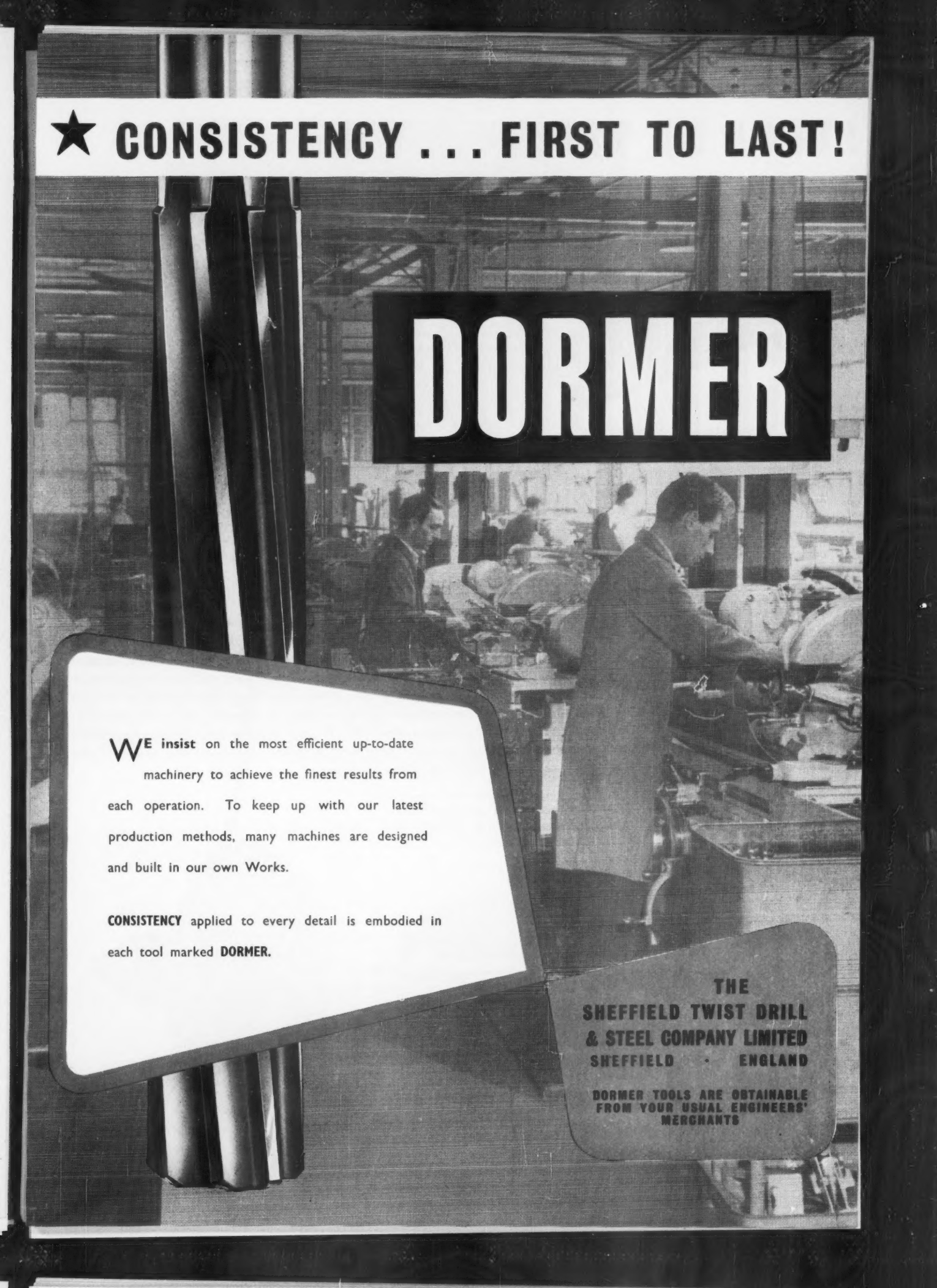
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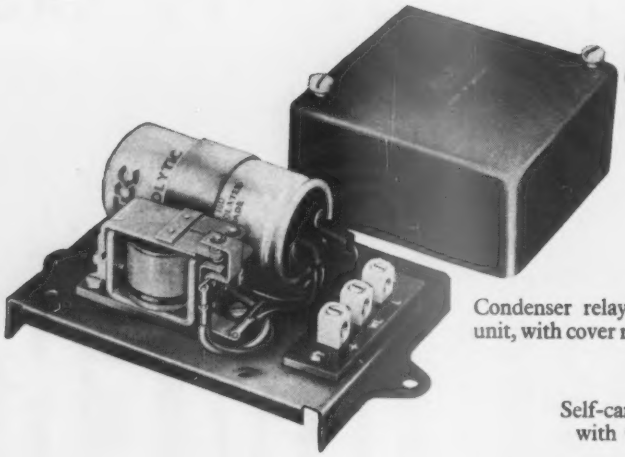
DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

NEW CONDENSER RELAY TYPE "CRF"



Condenser relay flasher unit, with cover removed

Self-cancelling switch, with warning light

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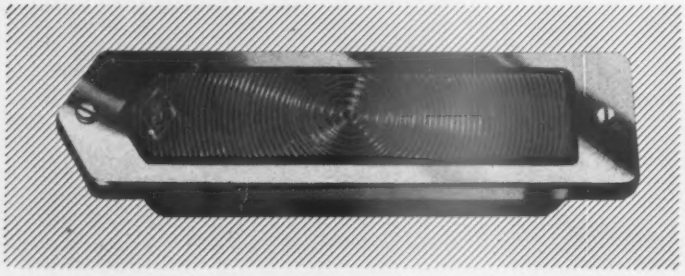
FOR COMMERCIAL VEHICLES

C.A.V. Flashing Indicator Equipment is designed especially for use on public service and transport vehicles, and is robust to ensure trouble-free operation. The new flasher unit is light, compact, and completely reliable, with only one working part, the relay, operated through an electrolytic condenser which is hermetically sealed and unaffected by temperature or moisture. Optical design of lamp units is carefully planned to give maximum visibility and attention value. Three types of lamp are available: circular for front or rear mounting; side-mounting type; and arrow type. All are single purpose lamps, giving unmistakable signals even in bright sunlight. Self-cancelling switch (illustrated) with adjustable time delay, or simple hand-cancelling type as required.

Sets suitable for tractor-trailer combinations. Particulars on application.



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RIGID FOAMS *Strong, light, and easily foamed in the space to be filled. Strongly recommended for the thermal insulation of houses and ships, and in aircraft construction.*

POTTING COMPOUNDS *Providing excellent electrical insulation, and protection against mechanical and thermal shocks.*

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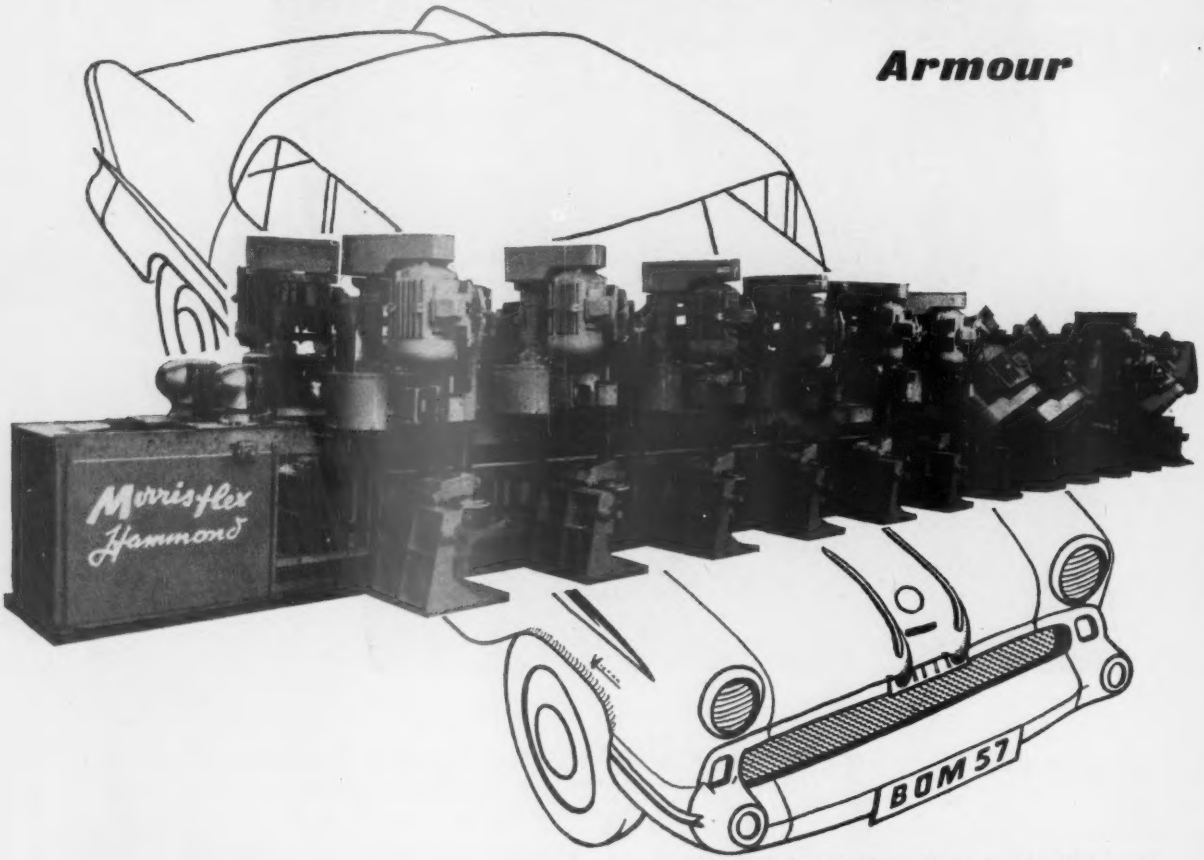

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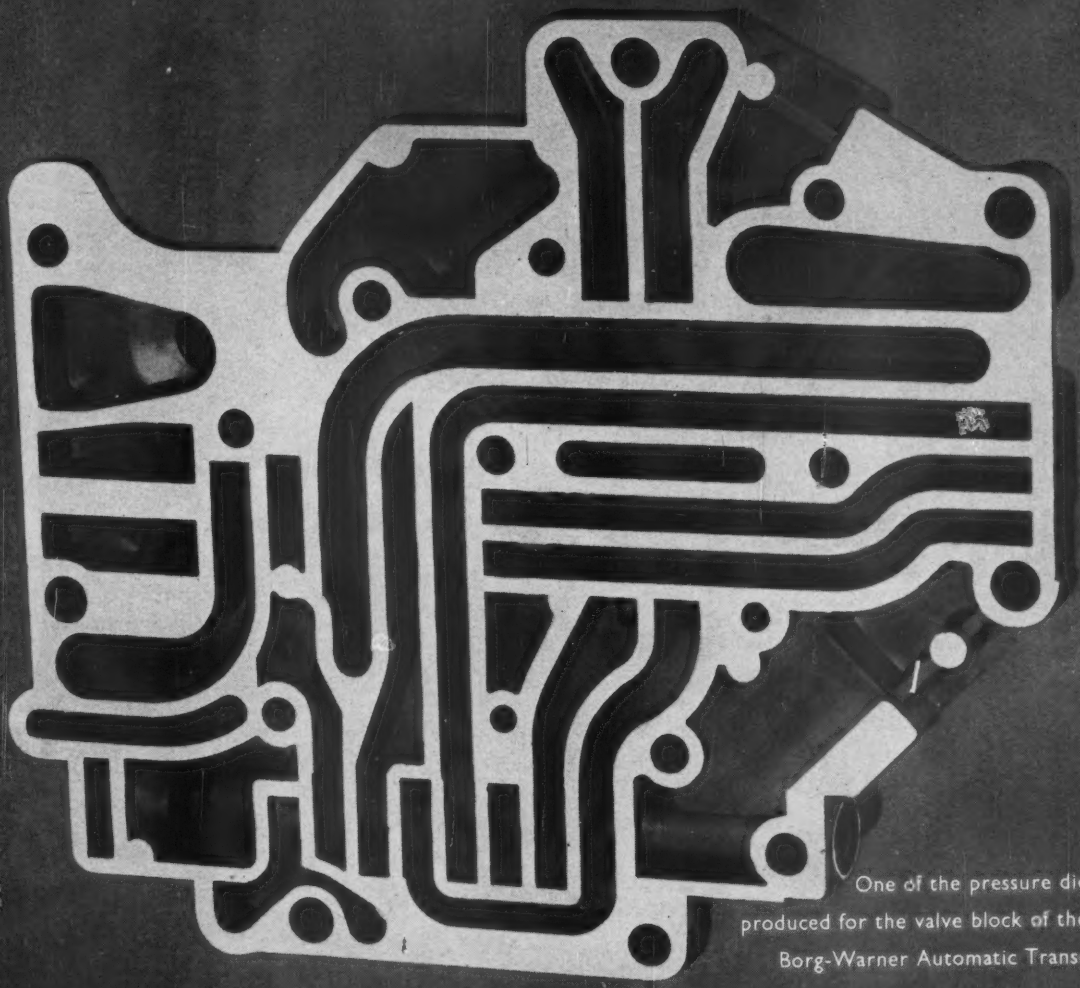

One of the pressure die castings
produced for the valve block of the
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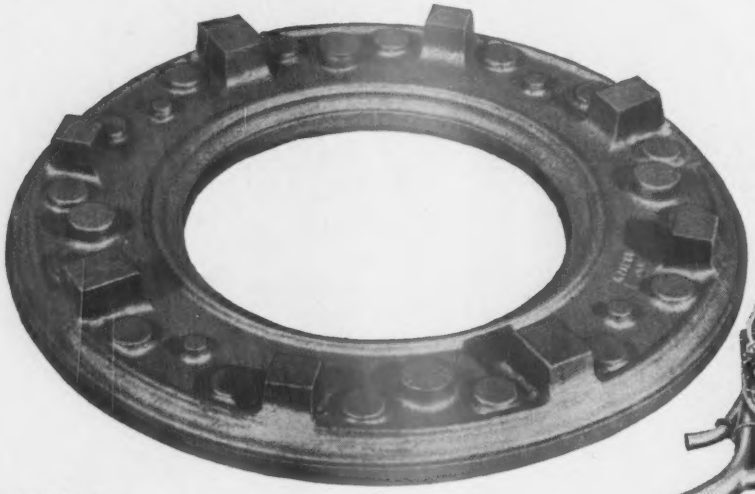

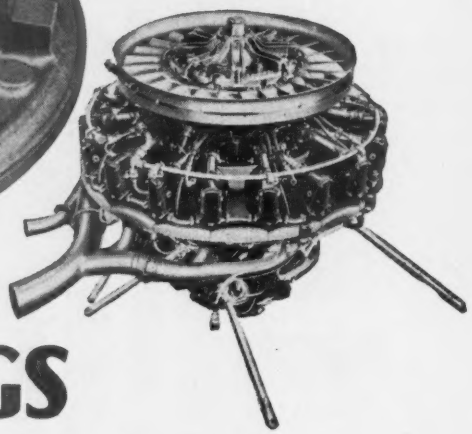

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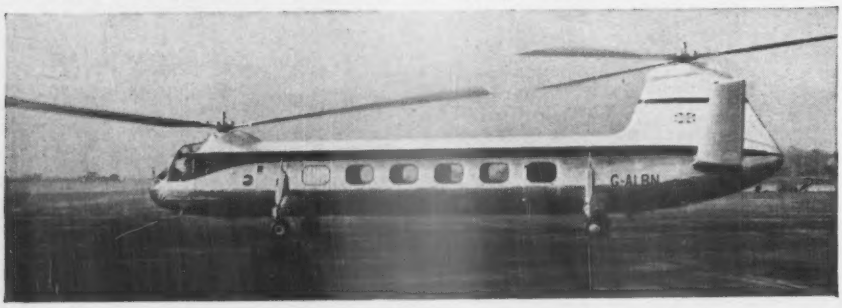
Harpers make the clutch plate castings used in Alvis Leonides engines, widely installed in helicopters. High strength, soundness and freedom from distortion are essential, as these castings provide the means by which the power is transmitted from the engine to the rotor blades.
Every casting is radiologically examined by Harpers to meet the requirements of the D.A.I.

Harper quality covers Grey Iron, Ductile Iron and Meehanite castings, also metal pressings and other finishes and sub-assembly work.



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. . . ask any motorist, whether he drives a revered veteran, the best car in the world, a track-tuned roadster or a home-made special.

The most useful modern metal - Stainless Steel - is being used more and more for motor-car trim and fittings. Stainless Steel is ideal for the job, no peeling or chipping, no polishing, all it requires is a wash with warm soapy water and a rub up with a leather.

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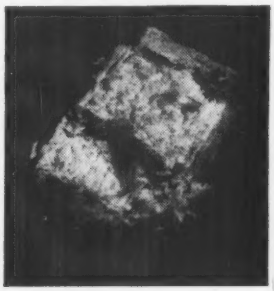
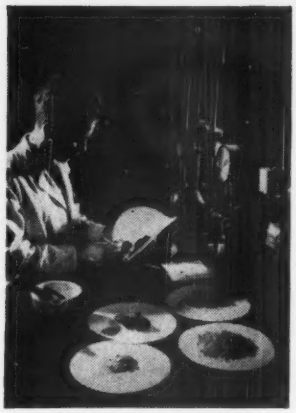
No. 1 Nine inches of safety



Specimen of asbestos-bearing rock with two wide seams of chrysotile fibre (the most-used white asbestos) cutting through



(Left) In the Ferodo Laboratories constant tests are made of raw materials and special equipment is used for making up test samples.

(Below) One section of the Ferodo Research Division is devoted to experimental production where the small-scale manufacture of new materials may be carried out on a production as opposed to a laboratory basis The illustration shows one of the machines used in the experimental production of moulded brake linings.

Nine inches . . . that's about the length of an average car brake lining. And not very much to look at, either. One motorist describing the woven-type lining, said 'rather like a bit of old Army webbing but stiffer!'

But this most modest and unspectacular car component carries a big responsibility. That's why Ferodo Limited investigate with such painstaking care the materials which go into its composition —their characteristics when taken in isolation and their friction properties in combination.

It starts with a bang.

In Rhodesia, Swaziland, the Transvaal, Quebec and elsewhere, mining engineers blast the rocks apart to obtain the basic material of all brake linings . . . asbestos.

A common enough material; most likely your garage is made of an asbestos cement . . . but, in reality, one of the earth's most baffling mysteries. For here is a soft, almost silky fibre that's really a mineral and blood brother to granite.

That's why asbestos is so right for brake linings; it's tough and flexible as fibre yet as non-inflammable and heat-resisting as rock. There are many different kinds of asbestos and they all have to be studied to select those that will give you brake linings that are safe —and stay safe!

This selection of asbestos has been difficult in past years because so very little was known about it.

But modern techniques, in particular, x-ray crystallography, have unlocked many of the secrets of asbestos. Ferodo scientists have been foremost among those engaged in this field of research. We now know, for example, that the chrysotile asbestos fibres used for brake and clutch linings are, in fact, bundles of ultra microscopic tubes. Indeed, a considerable portion of present-day knowledge of asbestos structure has been derived from the work of the Ferodo Laboratories.

But there's more to a Brake Lining than just asbestos.

To make an efficient friction material, resins and friction modifiers must be added to the asbestos.

There are scores of natural resins—and man has made many of his own, too! In the Ferodo Laboratories all these materials are studied, noted, assessed. The resins, which set hard when heated, and the friction modifiers are just as important as the asbestos constituent since they impart to the finished brake lining its durability, its consistency of performance and its anti-fade characteristics. When you apply your brakes and your car stops safely, smoothly, quietly, remember that Ferodo research has ensured that your Ferodo Anti-Fade Linings are as safe, hard wearing, as science can make them.

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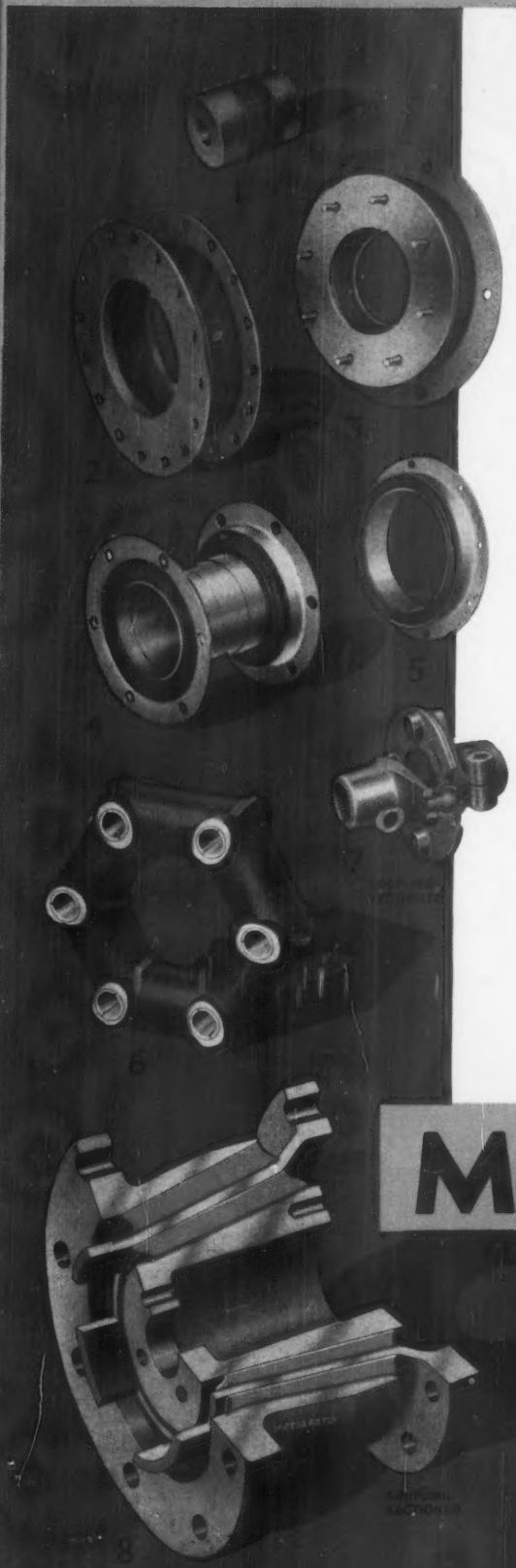

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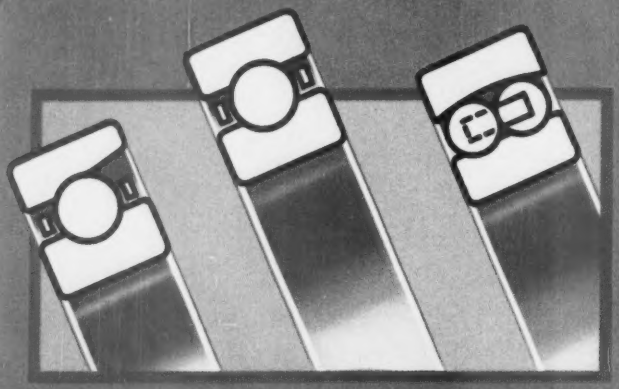

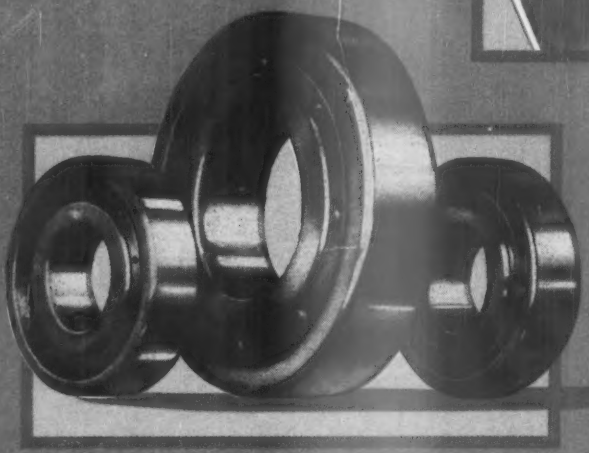

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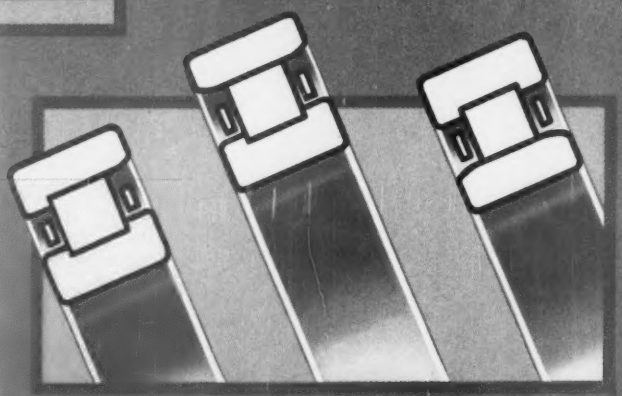

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THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

AUTOMOBILE ENGINEER

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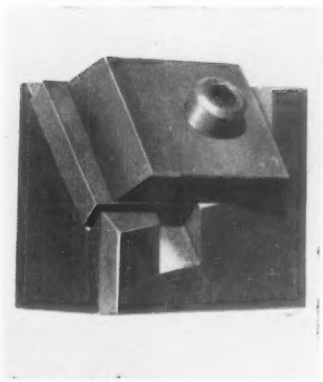

THE CROSS CHORD TOOL HAS ITS CUTTING EDGE INCLINED AT 50 DEG TO THE WORK AXIS. IT HAS AN EXCEPTIONAL PRODUCTION POTENTIAL ON FULLY HEAT-TREATED, ULTRA-HIGH TENSILE STEELS

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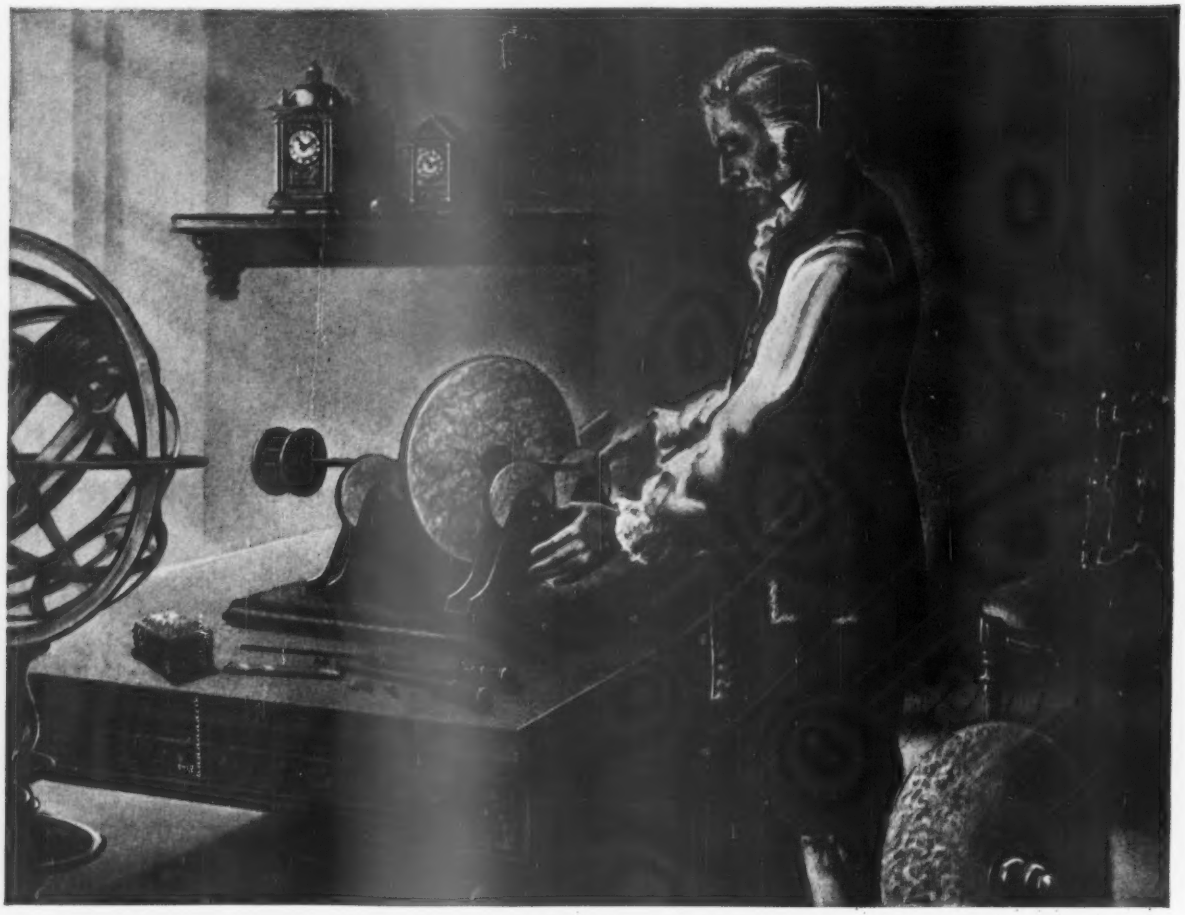

The Conquest of Friction

Instrument making flourished in the 18th century as scientific experiment became fashionable, and practical use was now made of several of the anti-friction devices first proposed by Leonardo da Vinci two centuries before. Henry Sully's chronometer (put forward in the competition for the prizes offered in 1714 by the Board of Longitude) employed such bearings, and Attwood in his 'machine' for demonstrating and measuring the acceleration due to gravity also successfully borrowed one of da Vinci's devices.

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F. C. Sheffield

DESIGN MATERIALS **AUTOMOBILE ENGINEER** PRODUCTION METHODS WORKS EQUIPMENT

Gas Turbines

ALTHOUGH gas turbines have largely displaced piston engines in aircraft applications, much development work remains to be done before they can be commercially acceptable as power units for road vehicles. The advantages that would be associated with a successful automobile unit are too well known to call for comment here, but attention may be briefly drawn to some of the problems that still await solution. There are three major problems:—(1) the specific fuel consumption, which at the present state of development is inordinately great in comparison with that obtained in petrol and diesel engines; (2) the very high peripheral speeds in conjunction with the inevitable very elevated temperatures create manufacturing difficulties as regards both materials and fabrication; (3) poor get-away from halts in traffic. On this last point, when a vehicle is stationary in a traffic block, the gas generator should not be kept running at high speed, because of the waste of fuel entailed and of the noise, which is much more noticeable when the vehicle is stationary. If, however, the gas generator is slowed down to a little above its self-sustaining speed, when the throttle is opened the rotating parts will, owing to their inertia, take some seconds in getting up to speed. In busy city traffic this could be a recurring nuisance to the driver of the gas turbine vehicle and to other road users.

At the present stage of development, the gas turbine for automobile use falls appreciably behind both petrol and diesel engines as regards thermal efficiency. The degree of inferiority is clearly shown in the accompanying table taken from a recent paper by Dr. J. H. Weaving of the Austin Motor Co. Ltd.

Vehicle speed	Thermal efficiency, per cent		
m.p.h.	Turbine	Petrol	Diesel
20	7·2	12·0	25·0
40	9·6	16·7	
60	13·3	21·0	
80	17·4	24·5	
90	18·8	24·5	35·0
Full load	20·2	26·0	35·0

Heavy vehicles, for which diesel engines are commonly used, appear to be more suitable than passenger cars for gas turbine operation, because they can accommodate relatively large heat exchangers. However, the difference between the thermal efficiency of diesel engines and the gas turbines developed for automobile use is so great it is obvious that much development work is still necessary before the gas turbine can be competitive with the diesel engine. As recent events have shown, the rate of specific fuel consumption is of paramount importance in road vehicle operation. On this basis, the gas turbine cannot compete with either petrol or diesel piston engines until a highly efficient heat exchanger to recover heat from the turbine exhaust can be produced commercially. A recuperative exchanger of the tube or plate type, if of adequate capacity, will be too bulky and, for a passenger car, too heavy or possibly too vulnerable. Therefore, a regenerative exchanger of the moving matrix type appears to be indicated. Such a unit will be costly to produce, and as yet, commercially practicable examples have not appeared, even for larger aircraft, marine, locomotive or industrial turbines. Two American car manufacturers have experimental units under development.

The automobile industry in this country, and the Rover Co. Ltd. in particular, can claim to have pioneered the gas turbine for road vehicles. It is, however, evident that large sums by British standards—perhaps even by American standards—will need to be spent on research and development before the gas turbine becomes a commercial proposition for road vehicle propulsion. In view of this, it is doubtful whether individual British organizations can compete with the American firms, and particularly General Motors Corporation, who are interested in this field. As we have said before in these columns, the development of gas turbines for road vehicles, is an appropriate field for co-operative rather than individual research in this country.

Finally, we would suggest that the development of either the free-piston gas generator and turbine or the piston engine and turbine compounded unit might give practical results earlier and at less cost. Either would be a simpler manufacturing problem than a gas turbine, would allow established techniques to be used, could employ the diesel cycle, and would simplify the materials problem on the turbine, since gas temperatures would be relatively low. They would also give a relatively low rate of fuel consumption and afford some advantages in facility of installation in a vehicle. Some interest in both these types of power units has already been shown in this country.

Bedford Diesel Engine

A 4·9 Litre Unit, With Reliefs Machined Below the Valve Seats to Promote Swirl

EARLIER this year Vauxhall Motors Ltd., announced its entry into the diesel engine manufacturing field by introducing a six-cylinder unit of 300 in³, or 4·9 litres, capacity. This new engine has been designed and developed by the Vauxhall engineering department at Luton and is in quantity production in the company's Dunstable factory, where Bedford vehicle manufacture is now concentrated. It is offered as an alternative to petrol power units in a reconstituted range of 4-, 5- and 6-ton Bedford trucks.

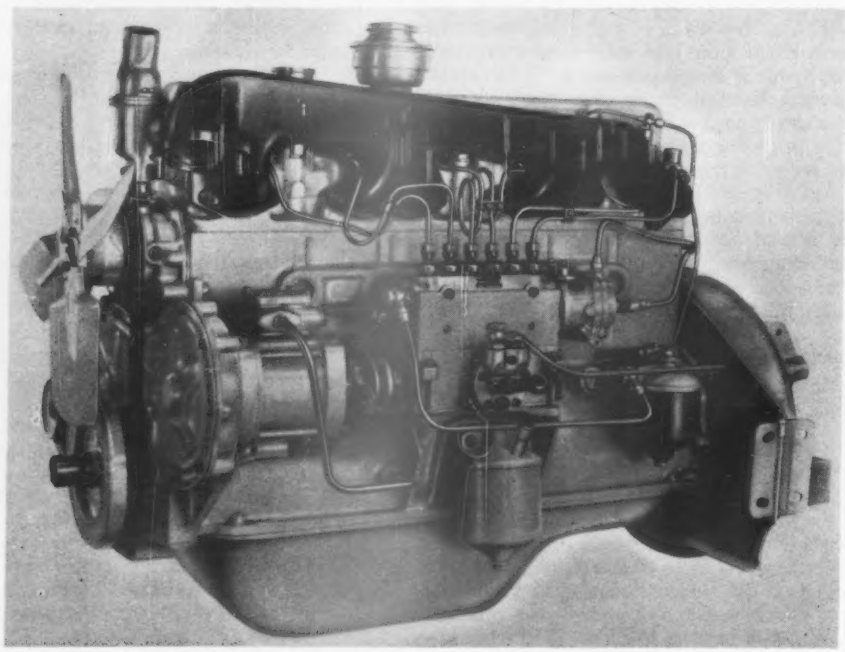
Fundamentally, the design of the engine conforms with accepted modern British practice in respect to four-stroke diesel units. Direct injection is adopted, in conjunction with toroidal combustion chambers in the piston crowns, on the score of the proved efficiency of this system and consequent economy of operation. In shaping the inlet ports so as to promote the air swirl necessary for complete combustion, rather than employing the alternative of masked inlet valves, the designers have achieved simplicity in assembly and servicing. Notably, the engine is designed to run at a speed substantially higher than has been customary among British diesel units of the direct-injection pattern. This characteristic can be said to reflect signs of a gradual move away from the traditional relatively slow-running oil engines towards units with speed and acceleration capabilities more nearly approaching those of contemporary commercial vehicle petrol engines.

The fuel pump is of the conventional pattern, with in-line elements. It is driven, in tandem with a rotary exhauster for the vehicle braking system, by helical timing gears at the forward end of the engine. One integral casting forms the crankcase and cylinder block unit, into which readily replaceable liners are inserted. The inlet and exhaust manifolds are secured to opposite sides of the cylinder head. Two forms of exhaust manifold are produced to suit engine installations in either normal- or forward-control vehicles and for the same reason two types of engine mountings are available.

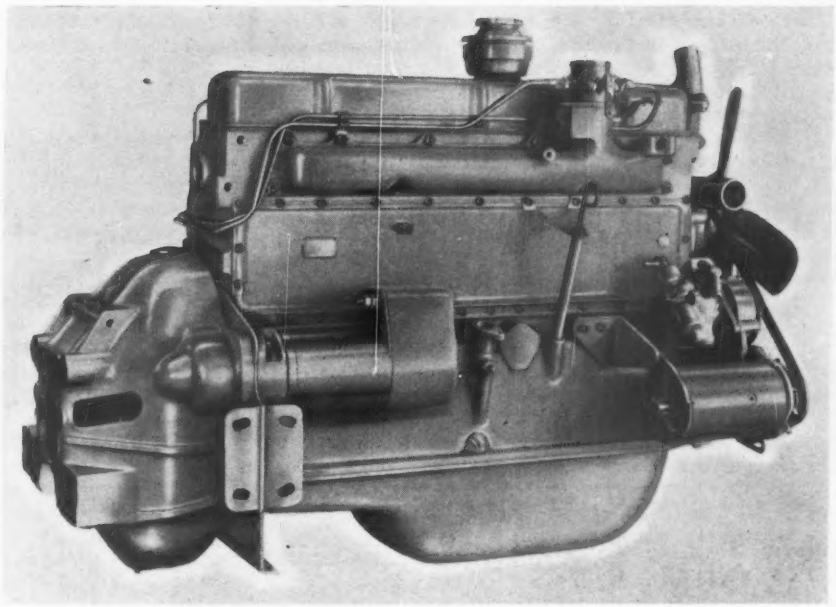
At the same time as production of this engine was begun, certain design changes were introduced into the existing 300 in³ Bedford petrol engine. The object of these modifications was to effect a degree of standardization among many of the major components of this engine and those of the new diesel engine. This enabled a large proportion of the machine tooling to be common to both units. For example, items such as the crankshaft and the camshaft, the bearings associated with these components, the oil pump and many of the valve operating parts are common to both engines. The bore and stroke dimensions and the distances between the cylinder axes are also the same for the two engines; and, although the finished cylinder block for the petrol engine is not, in fact, interchangeable with that of the diesel unit, it is produced from the same casting and both types can be machined on the same production line.

This rationalization has a number of economic advantages. One is that manufacturing costs are spread over a large number of units; this is reflected in the relatively small additional cost to the customer of a Bedford truck equipped with a diesel by comparison with that of a petrol engine. The interchangeability of so many of the spare parts of the two power units is of benefit to service organizations and to many transport operators.

Respectively, the bore and stroke dimensions are $3\frac{7}{8}$ in and $4\frac{1}{4}$ in; this gives a bore: stroke ratio of 1·097:1 and a swept volume of 300·75 in³. A compression ratio of 17:1 has been



On the Bedford diesel engine a conventional drive arrangement is employed for the auxiliaries; that is, the fan and dynamo are driven by a triangulated V-belt, while helical gears drive the exhauster and injection pump, which are coupled in tandem



A long, box-shape casting forms the induction manifold of the Bedford diesel engine; bolted on top of it is a venturi, with connections for the pneumatic governor. The cylinder block and crankcase casting is common to the Big Bedford petrol engine and incorporates the flange for the contact breaker and distributor unit

adopted and the connecting rod:stroke ratio is 1·794:1. The maximum power output is 97 b.h.p. at 2,800 r.p.m., and the maximum torque is 217 lb-ft at 1,400 r.p.m. At maximum b.h.p., the mean piston speed is 1,980 ft/min. The maximum b.m.e.p. is 109 lb/in² at 1,400 r.p.m., and the minimum specific fuel consumption is of the commendably low order of 0·364 lb/b.h.p-hr; this consumption is obtained at 1,600 r.p.m., when the engine output is 50 b.h.p. Since the dry weight of the engine, including the clutch housing, clutch assembly and flywheel, is 1,044 lb, the output relative to weight is 0·0926 b.h.p/lb.

The foregoing data concerning maximum output and torque are obtained with the test-bed exhaust system, no fan, the generator not charging and with fixed injection timing and rate. Corresponding figures taken from a dynamometer test planned to reproduce actual operating conditions obtained when the engine is installed in a vehicle show the maximum b.h.p. to be 89 at the normal governed speed of 2,600 r.p.m. and the maximum torque 210 lb-ft at 1,400 r.p.m. In this case the figures were obtained with the standard vehicle exhaust system and air cleaner fitted, the fan in operation, but with the dynamo not charging and the fuel injection timing and rate fixed. The overall dimensions of the engine less air filter are: height 34·26 in; width 26·72 in; and length less flywheel 38·34 in.

Cylinder block and crankcase

A chromium-iron cylinder block and crankcase unit is employed. Measured from the surface of the top deck to the abutment face for the main bearing housing cap, the depth of the unit is 12·529-12·534 in. Below the level of the crankshaft axis the crankcase skirt extends about $2\frac{5}{8}$ in to add stiffness to the casting. Additional rigidity is afforded by substantial internal ribs disposed transversely to correspond with and support the crankshaft bearing housings. At their upper extremities each of these ribs is reinforced locally and drilled and tapped to receive a $\frac{9}{16}$ in En 8D stud. There are thus 14 of these studs and they are about $13\frac{1}{4}$ in long. Set vertically, they extend upward from the base of the cylinder block through the water jackets and project $4\frac{1}{2}$ in above the top deck to hold down the cylinder head. This arrangement helps to maintain the cylinders free from distortion, since it transfers much of the working load directly to the base of the cylinder block, so relieving the strain in the area surrounding the cylinders themselves. To protect the studs against corrosion due to continual contact with the coolant, they are bronze plated.

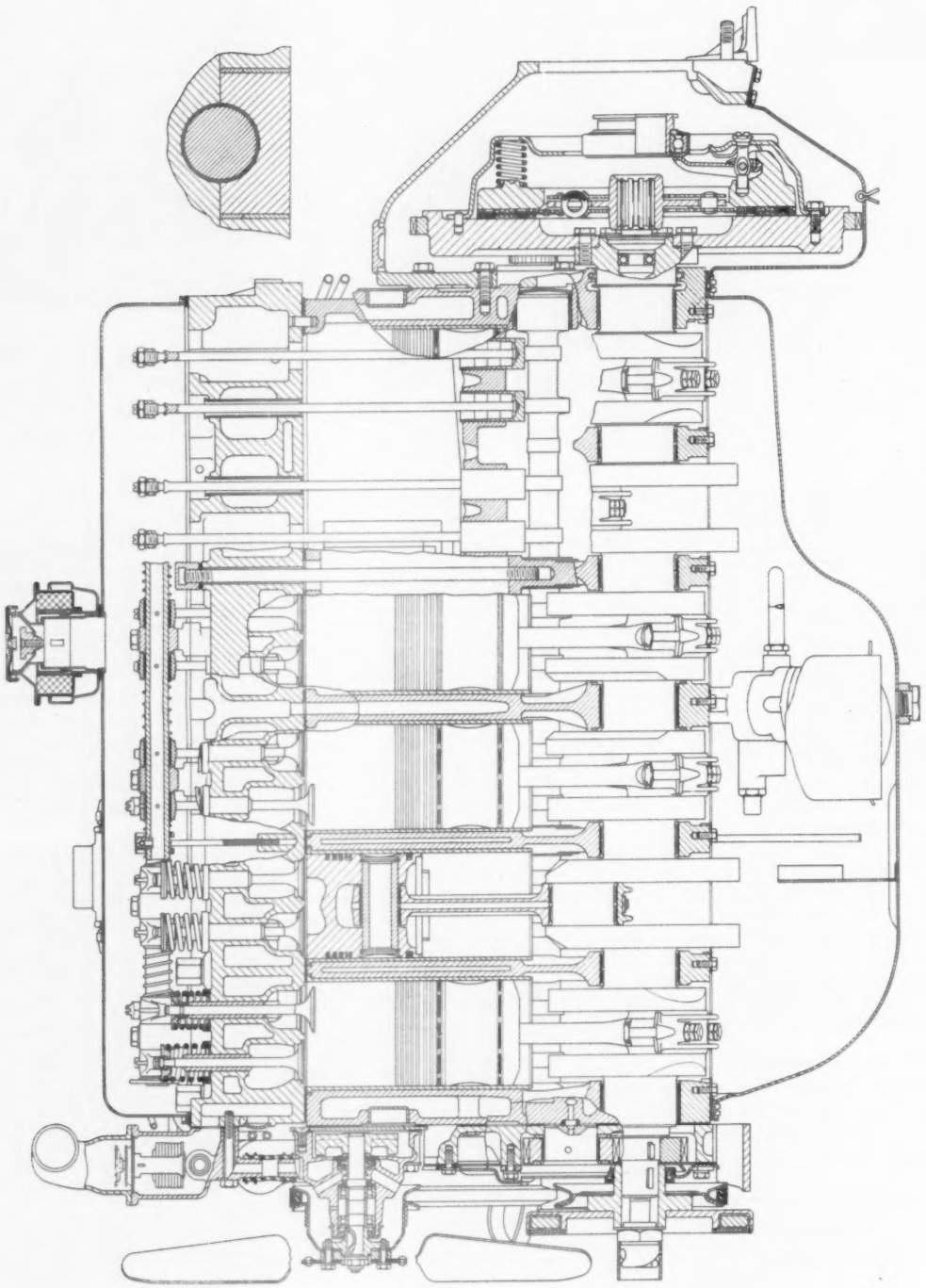
A pressed steel sump is bolted to the machined face at the lower edge of the skirt. The edges of the sump are shaped to form an inverted channel section flange, which is stiffened between the bolt holes by swaged indentations. Between the joint faces a composition cork washer, $\frac{1}{16}$ in thick, affords an oil-tight seal. The base of the sump is also stiffened by indented longitudinal grooves and a transverse baffle plate is spot welded inside.

The camshaft is housed on the right hand side of the casting. Its axis is about $3\frac{1}{2}$ in above and $3\frac{3}{4}$ in to one side of that of the crankshaft. In this position, the camshaft tunnel reduces the depth of the water jacket on that side by only about $\frac{1}{4}$ in. A good feature is that the water jacket extends up above the highest level reached by the top rings of the pistons. The top deck thickness is $\frac{9}{16}$ in, the cylinder walls are $\frac{1}{4}$ in thick, and between the cylinder walls, the minimum water jacket space is $\frac{3}{16}$ in.

Counter bores are machined in the upper ends of the cylinders to accept the 0·22 in wide by 0·187 in thick flanges of the cylinder liners. These liners are of centrifugally cast alloy iron and are supplied by Hepworth and Grandage Ltd. Their wall thickness is $\frac{1}{8}$ in, and they are a slip fit in the bores, with clearances of 0·001-0·003 in. The liners are held in position by the pressure exerted on their flanges by the laminated steel gasket employed between the cylinder block and head. A shallow recess is machined round the inner edge of each flange, to relieve it of pressure except

SPECIFICATION

Six cylinders. Bore and stroke $3\frac{7}{8}$ in and $4\frac{1}{2}$ in respectively. Swept volume 300·7 in³ (4·927 litres). Maximum b.h.p. 97 at 2,800 r.p.m. Maximum b.m.e.p. and torque 109 lb/in² and 217 lb-ft at 1,400 r.p.m. Compression ratio: 17:1. Forged seven-bearing crankshaft, fully balanced. Overhead valves operated by push rods. C.A.V. injector pump, type AAL6B75/82E and C.A.V. injector nozzles, type BDLL 160S6173. Direct injection. Combustion chamber formed by toroidal cavity in piston crown. C.A.V. fuel lift pump, type DFP6/4. C.A.V. fuel filter, type F2/1 with paper cartridge.



ARRANGEMENT OF THE BEDFORD DIESEL ENGINE
Bore 3⅞ in Stroke 4¼ in Swept volume 300·7 in³

where it is directly supported on the shoulder in the cylinder bore. In this manner the risk of flange failure due to localized or uneven loading is minimized.

Crankshaft and flywheel

The journals and crank pins of the seven-bearing En 8D crankshaft are induction hardened by the Tocco process, and the fillet radii are subjected to cold roll peening to introduce a compressive stress at these vital junctions. Such treatment is unusual; and its object is, of course, to obviate the development of fatigue cracks in these areas. Each web is 0·844 in thick and embodies a counterweight. A Holset viscous-fluid type torsional vibration damper is fitted at the forward extremity of the crankshaft, where it projects forward of the timing case cover. Between the front face of the front web and the back of the rear web the crankshaft length is 27·53 in. The journals are 2·75 in and the crank pins 2·375 in diameter, and the effective journal bearing lengths on which the bearing loading is calculated are: front 1·28 in; centre 1·43 in; rear 1·06 in; and the remainder 0·9 in. The overall lengths, including the oil grooves, are: front 1·412 in; centre 1·433 in; rear 1·18 in; remainder 1·023 in. This gives a total projected bearing area of 19·38 in².

The main bearings are of the pre-finished thin steel shell type lined with indium flashed copper-lead; they are supplied by Vandervell Products Ltd. White-metal faced steel thrust washers fitted on both sides of the centre bearing locate the shaft axially. The diametrical running clearance of the bearings is 0·002-0·0045 in. As is usual with this class of bearing, shell location is effected by means of projecting tags on the shells registering in corresponding slots in the bearing caps and seatings. Broached slots in the crankcase locate the main bearing caps, and each cap is held down by two ½ in diameter set bolts of 1·5 per cent nickel-chrome steel: their heads are locked in pairs by the bi-hexagonal ends of spectacle-shaped plates, which bridge each bearing cap and are held in place by a central set bolt. This is a simpler locking method than the more usual one of employing wire.

To the rear of the rear main journal, an oil thrower ring is machined on the crankshaft, and behind that is a ⅝ in thick, 4¾ in diameter flange to carry the flywheel. The oil thrower ring revolves in an annular clearance groove machined in the crankcase and in an extension of the rear main bearing cap. Oil thrown into the groove drains back to the sump through drilled holes in the bearing cap. A second annular groove, to the rear of the oil thrower, houses a graphited asbestos strip packing in contact with the crankshaft to form an oil seal. Closure of both ends of the crankshaft is effected by extensions of the front and rear bearing caps. Vertical faces machined on the sides of the caps abut against the corresponding faces of apertures in the crankcase and are grooved vertically to receive Kautex packing strips to seal the joint effectively.

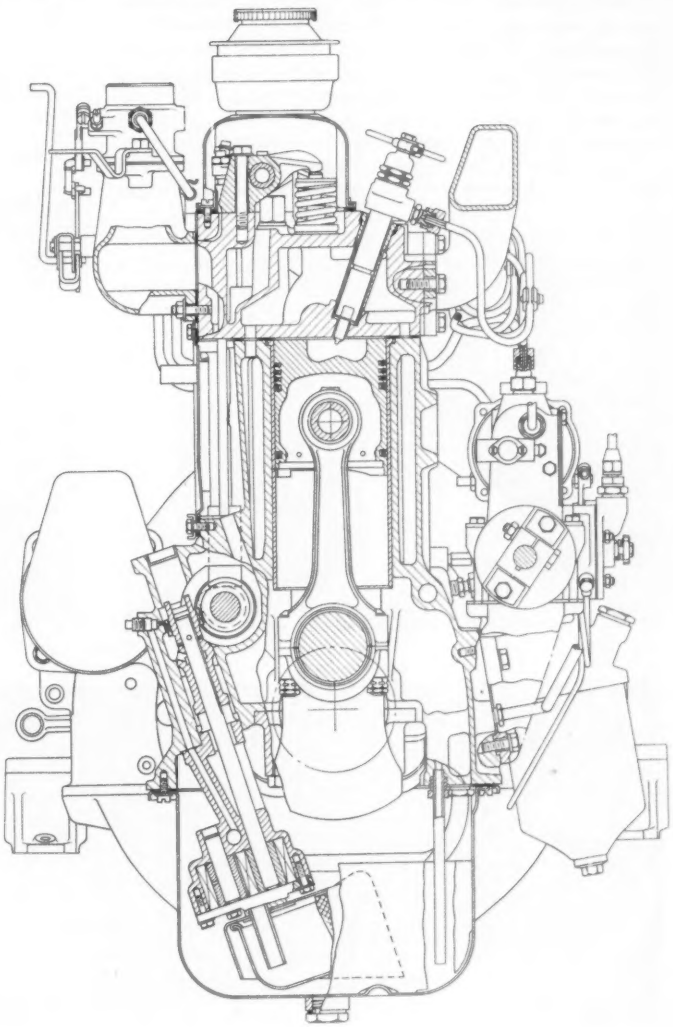
The flywheel is of B.S.1452 grade 17 cast iron and is secured to the crankshaft flange by six $\frac{7}{16}$ in set bolts and located by two ½ in diameter dowels. It is 1 $\frac{11}{16}$ in thick by 16 in diameter and weighs 59½ lb. The moment of inertia is 2,311 lb-in². The oil hardened En 43B starter ring has 134 teeth and is shrunk on to the periphery of the flywheel.

Keyed to the forward end of the crankshaft are: first, the timing gear drive pinion and then a flanged hub. The rear face of the flange carries the fan driving pulley and the front face the vibration damper. Both these units are secured to the flange by six rivets and the hub is retained on the shaft by the starting dog, which is screwed into the end and locked by a tab washer.

Connecting rod and piston assemblies

Stamped H-section connecting rods of En 18A are employed and have a centre-to-centre length of 7⅝ in. Their cross sectional dimensions are: width over flanges 1·12-1·32 in; depth 0·75 in; and web thickness 0·28 in. Each rod assembly, complete except for the big-end bearing weighs 3·4 lb. A vertical oil hole is drilled through the web to lubricate the gudgeon pin bearing and another is drilled diagonally in the big end bearing housing to direct oil on to the thrust side of the cylinder bore.

The big end bearings are of the same type as the journal bearings and they also are located by lugs on the bearing



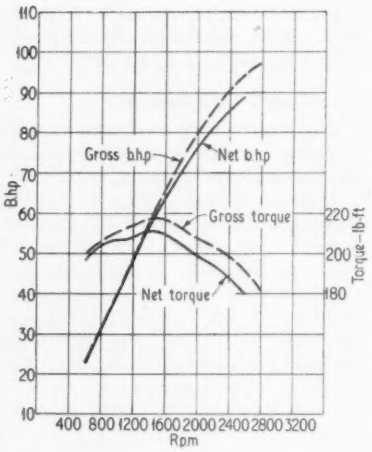
Cross section of the engine, showing the oil pump and its drive. Each combustion chamber and the tip of its injector nozzle are offset $\frac{5}{16}$ in from the axis of the cylinder; the head is sleeved to house the injector body

PISTON RING DATA

	Top	Second	Third
Compression rings:			
Gap	0·015 in	0·011 in	0·011 in
Face width	0·094 in	0·094 in	0·094 in
Radial thickness	0·162 in	0·162 in	0·162 in
Depth of groove in piston	0·192 in	0·192 in	0·192 in
Side clearance	0·0055 in	0·0025 in	0·0025 in
Oil control rings:			
Gap	0·011 in	0·011 in	
Face width	0·018 in	0·018 in	
Radial thickness	0·162 in	0·162 in	
Depth of groove in piston	0·207 in	0·207 in	
Side clearance	0·0025 in	0·0025 in	

The ring dimensions given are the average of the limits, and the depth of groove dimension is only approximate because of the ovality and taper of the piston

The gross power and torque curves were obtained in a conventional dynamometer test with the test bed exhaust system, no fan, the generator not charging and with fixed fuel injection timing and rate. Net power and torque were taken from a dynamometer test simulating road operating conditions. The vehicle exhaust system and an air cleaner were fitted, the fan was in operation, but the generator was not charging and a fixed fuel injection timing and rate were adopted in the tests



shells and corresponding slots in their housings. Their length is 1·217 in and their diametrical clearance is 0·002-0·004 in. Since the big ends are not too wide to be withdrawn through the cylinder bores, they are split at 90 deg. Two $\frac{7}{16}$ in diameter high tensile steel bolts and nuts retain each bearing cap and are locked by Palnuts.

Steel-backed lead-bronze bushes, 1·34 in long, are pressed into the small ends with an interference fit of 0·004-0·005 in. The gudgeon pins are produced from En 36C bar and are case hardened; their internal and external diameters are $\frac{27}{32}$ in and 1·3750-1·3748 in respectively and the length of the bearing area in each piston boss is 0·765 in. Circlips in grooves at the ends provide axial location for each pin.

Hepworth and Grandage aluminium-silicon alloy pistons, heat treated to Brinell 125-140, are employed; each weighs 2·55 lb. A straight-sided toroidal cavity is formed in the piston crown. It is offset from the centre of the piston to correspond with the offset of the injector nozzle tip in relation to the cylinder bore. Each piston is 4·649-4·632 in long and the measurement between the gudgeon pin axis and the face of the crown is 2·802-2·799 in.

There are three compression rings and two grooved and slotted oil control rings in each piston. The top compression ring has a taper face and is chromium plated; the other two are stepped internally. Above the top ring, four circumferential scuff lands are formed on the piston. The lower of the two oil control rings is below the gudgeon pin.

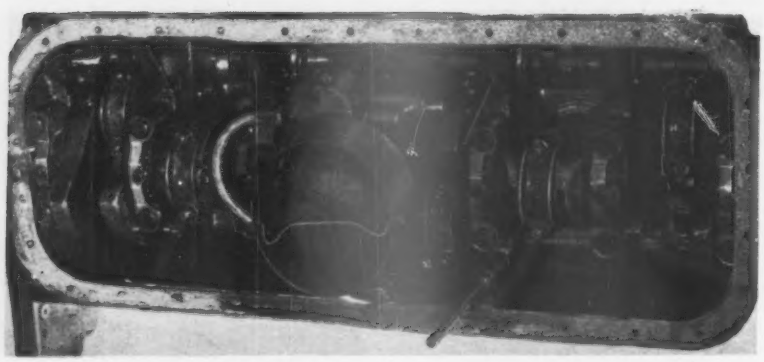
Timing gear

A cast iron timing case is secured to the front face of the crankcase by fifteen $\frac{5}{16}$ in diameter bolts and located by two $\frac{1}{2}$ in diameter dowels. It is closed by a cover formed by a mild steel pressing. A Super oil seal is housed in the aperture through which the hub of the vibration damper and fan drive pulley unit protrude. The timing gear drive arrangement is orthodox; all the helical pinions are of En 16M.

The crankshaft pinion meshes with the half speed wheel and with an idler gear through which the drive is transmitted to the exhauster and fuel pump pinion. A bronze bush is pressed into the boss of the idler gear, which is free to revolve on a fixed pin. There is a thrust washer on each side of the idler gear. At its inner end, the idler gear pin registers in a counterbore. Its outer end is flanged and drilled to receive two $\frac{5}{16}$ in diameter bolts, by means of which it is pulled up against the faces of two bosses in the timing case.

The exhauster driving gear is keyed to the front end of the exhauster rotor shaft. It is pulled against an abutment washer by a plain washer, tab washer and nut. The exhauster is a Clayton Dewandre RE.GA 305-1 unit of the rotary

Above, left: Piston and connecting rod assemblies. Each connecting rod is drilled axially for the lubrication of its small end



Left: The skirt of the crankcase extends well below the level of the axis of the crankshaft, and the main bearings are supported by substantial transverse ribs

sliding vane type. Its casing spigots into the back of the timing case casting and is secured there by six $\frac{5}{16}$ in diameter set bolts. A C.A.V., CN2 type flexible coupling for the fuel injection pump is keyed on the rear end of the rotor shaft. This coupling is secured by a clamp bolt.

Camshaft and valve gear

The half speed wheel is keyed to the camshaft and held by a plain washer and a nut locked by a tab washer. Axial location of the camshaft is effected by a tin-plated mild steel thrust plate between the back of the half speed wheel and the forward face of the front bearing journal. This thrust plate is secured to the timing case by two set-bolts. The En 8C camshaft is carried in four Vandervell steel-backed white-metal bearings. Between the cams, its diameter is 1·125 in. The diameters and lengths of the bearings are: front 2·1362 in by 1·44 in; rear 1·937 in by 1·16 in; front intermediate 2·046 in by 1·0 in; and rear intermediate 2·003 in by 1·0 in. Their diametrical clearance is 0·0025-0·004 in. Mid-way between the two intermediate journals, a spiral gear is formed on the camshaft to drive the oil pump.

The cams have an effective lift of 0·3116 in and their nominal periods are: inlet, duration opening 83 deg; and exhaust, duration closing 88·8 deg. At 3,500 engine r.p.m. when the tappet is on the flank of the cam its maximum positive acceleration is approximately 4,050 ft/sec²; the maximum negative acceleration, occurring at the nose of the cam, is 2,520 ft/sec². These figures apply to both the inlet and the exhaust valves.

Chilled cast iron tappets of the barrel type are employed. They are 1·125 in diameter and their diametrical clearance in their guides is 0·0005-0·002 in. The En 8B push rods are $\frac{5}{16}$ in diameter and have an effective length of 13·136 in. A spherical lower end and a cupped upper end are upset

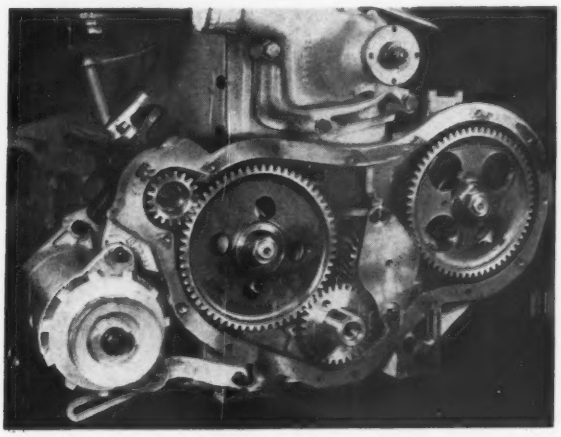
VALVE DATA

	Inlet	Exhaust
Material	En 43 C	En 45 C stem, austenitic head
Head diameter	1·687 in	1·470 in
Throat diameter	1·406 in	1·315 in
Stem diameter	0·3413 in	0·3402 in
Diametral clearance in guide	0·0019 in	0·003 in
Seat angle	30 deg	45 deg
Valve seat material	No renewable seat	
Spring material	Swedish wire, Brunton, or B.S.1408	
Spring rate	267 lb/in	
Spring length, free	1·869 in	
Spring length, installed	1·682 in	
Spring natural frequency	24,500 c.p.m.	
Number of coils	Total 6 (4 active)	
Coil diameter	1·223 in	
Wire diameter	0·192 in	
Valve lift	0·398 in	
Rocker ratio	1·32:1	
Valve guide material	Cast iron CI 3	
Valve guide length	2·84 in	2·55 in
Valve guide:		
inside diameter	0·3432 in	
outside diameter	0·625 in	
Tappet clearance	0·013 in	
Valve opens	10 deg B.T.D.C.	46·8 deg B.B.D.C.
Valve closes	66 deg A.B.D.C.	36 deg A.T.D.C.

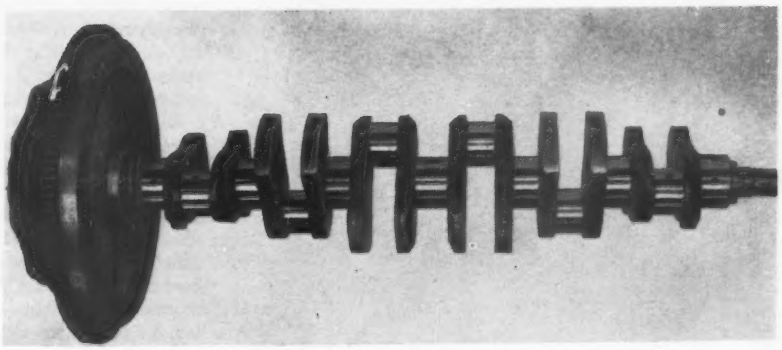
on each. The rockers are of En 8C, and their pads are hardened to Rockwell C50. Conventional tappet adjusting screws with spherical heads are employed. They are machined from carbon steel bar hardened to Rockwell C53. Into the rocker eyes hard rolled brass bushes, $\frac{27}{32}$ in long, are pressed.

All the rockers are carried on a single tubular shaft of En 9, with inside and outside diameters of 0·519-0·520 in and 0·8736-0·8729 in respectively. The shaft is supported on six LM2M aluminium alloy pedestals, each of which is secured to the cylinder head by a $\frac{7}{16}$ in diameter set bolt and a plain washer. Coil compression springs hold the rockers against the pedestals. The ends of the rocker shaft are sealed by plugs, and each of the two outer rockers is retained, between a washer and the face of the outer pedestal, by a hairpin type spring clip.

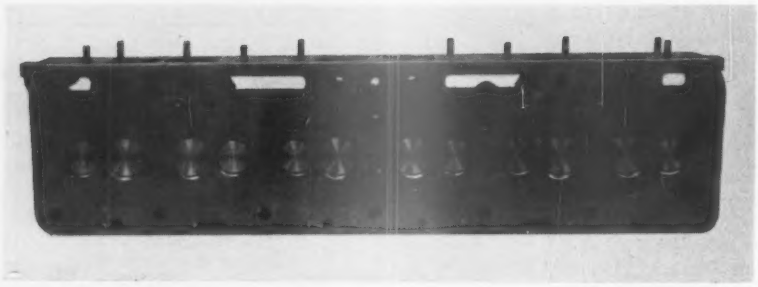
All the valves are disposed in line in a vertical plane. The distance between the axes of adjacent inlet and exhaust valve stems is $1\frac{1}{16}$ in. A single spring is fitted to each valve. The lower end of each spring seats in a shallow cup fitted over the upper end of the valve guide, and the upper end bears against a shouldered cap. In the case of the inlet valves, the caps are retained in the usual manner by tapered split collets. But on the exhaust valves, narrow, flat split-collars in specially shaped recesses in the valve stems are employed to retain the shouldered cap. An end cap fitted over the head of the valve stem bears against the split collar



Above: The small pinion meshing with the half speed wheel actuates the hydraulic pump of the power-assisted steering system



Right : The seven-bearing crankshaft, together with the flywheel and clutch assembly, showing the arrangement of the counterweights on the webs of the crankshaft



Left: The lower face of the one-piece cylinder head is machined flat; in this view, the face to which the inlet manifold box casting is bolted is uppermost

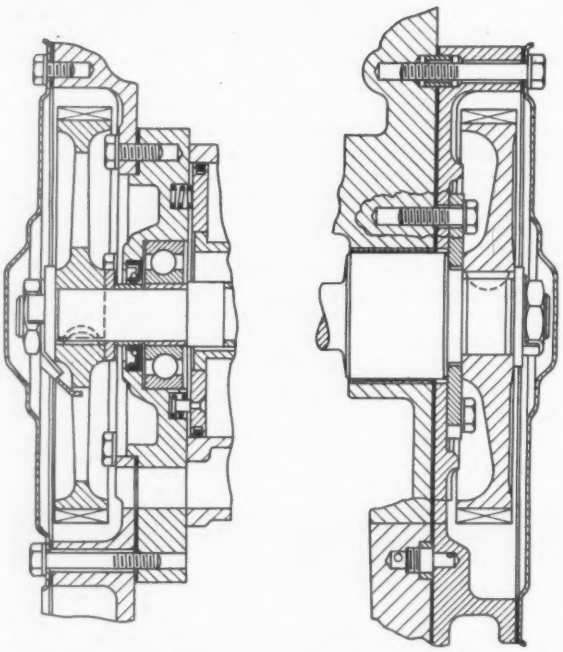
so that as the valve is lifted off its seat it is relieved of spring pressure and is free to rotate. This arrangement is one that has been used successfully in previous Vauxhall engines.

Plain cylindrical section cast iron valve guides are employed. Those for the inlet valves are 2·84 in long and those for the exhaust valves 2·55 in long. They do not project into their ports. The valves have flat-topped heads and, unusually, the exhaust valves are of the composite type having heat-resisting Austenitic heads on 45 ton carbon-steel stems.

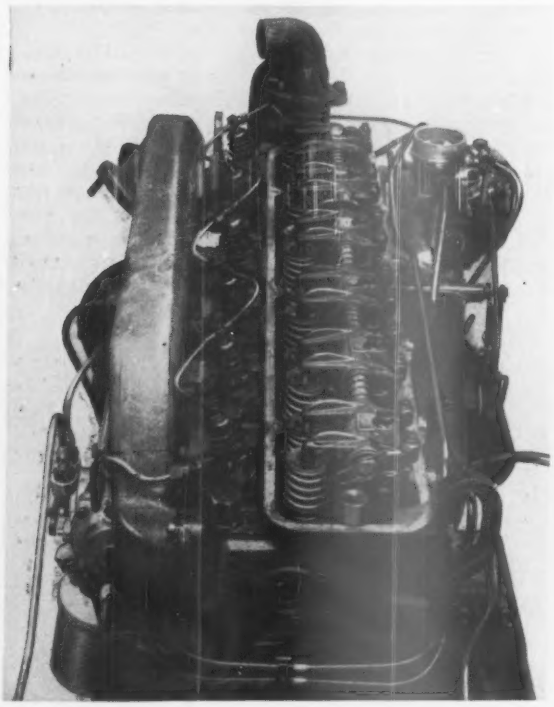
Cylinder head and manifolds

The chromidium cast iron cylinder head is about 4½ in deep × 7⅝ in wide × 30¾ in long. It is a robust slab-casting with a flat lower face, pulled down by 14 cap nuts on to a Coopers laminated steel gasket. Substantial bosses extending the full depth of the cylinder head are drilled $\frac{19}{32}$ in to clear the holding-down studs. These bosses reinforce longitudinal walls of the cylinder head and take the compression caused by tightening down the retaining nuts. Plain washers of leaded brass, below the nuts, seal the stud clearance holes.

Individual exhaust and inlet ports are incorporated in the cylinder head. The exhaust outlets are on the left-hand side and the inlet port entries on the right. At its entry, each inlet port is rectangular in shape, with radiused corners; the cross-sectional dimensions are 2¼ in deep × 2½ in wide.



Above: Sections of the exhauster and camshaft drive arrangements

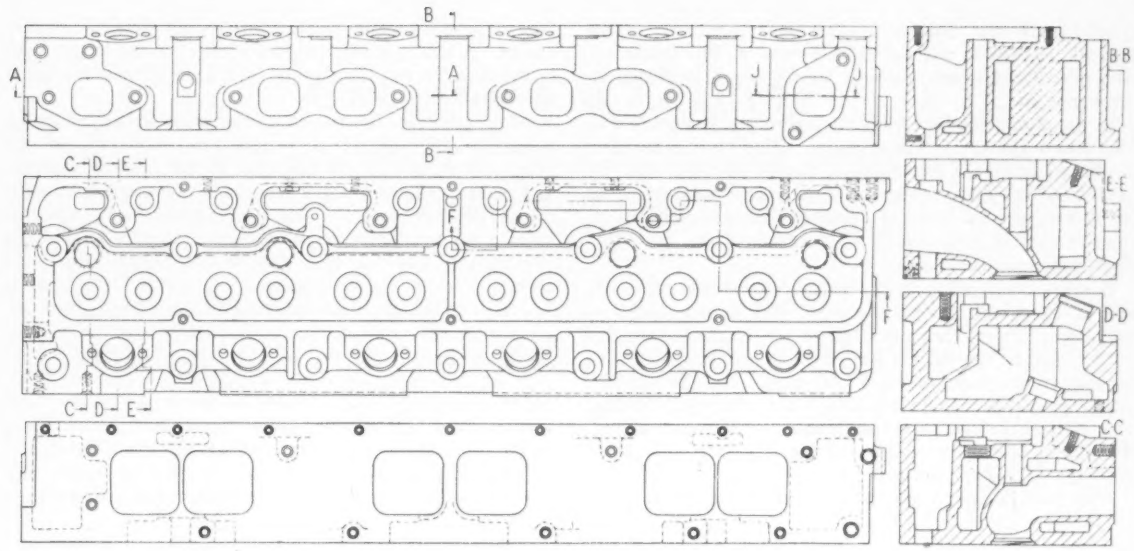


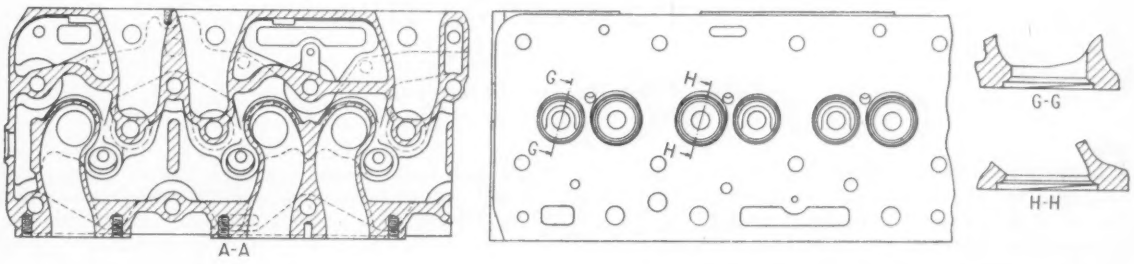
Left: The valves, each with a single spring, are carried vertically in line in the cylinder head and are push-rod-and-rocker actuated

The throat of the port narrows gradually and becomes progressively more circular in section as it nears the valve seating. Below the actual seating, the opening is relieved on one side to increase the air swirl initiated by the shape of the port as the valve opens.

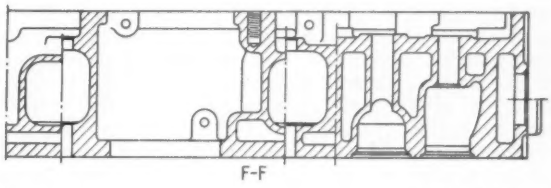
The C.A.V. BKBL975673 type nozzle holders are set at an angle of 20 deg from the vertical and offset $\frac{4}{16}$ in from the centre of the cylinder bore, in conformity with the offset of the combustion cavity. Four-hole type injector nozzles are employed. Surrounding each injector is a shouldered steel sleeve pressed into a seating in the water jacket in the cylinder head. The sleeve, which is sealed at its upper end by a rubber ring, is copper-plated to protect it from the corrosive effects of the coolant round it.

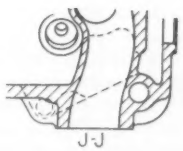
A long aluminium box casting is employed instead of a conventional inlet manifold. One side of the box is open so that, when it is bolted up against the head, it encloses the entries to the six inlet ports. The joint is sealed by a gasket of fibre or oil-resisting paper. A vertical air inlet pipe is embodied near the forward end of the inlet box. The exhaust manifold is an iron casting incorporating single branch pipes for the front and rear cylinders and two pairs of branch pipes for the intermediate cylinders. A gasket is not fitted between the branch pipe flanges and the head.





At the top of this page, three views of the cylinder head are shown, with four cross sections on the right-hand side of them. The plan section AA, below them on the left, shows the porting arrangement. To the right of this are the sections GG and HH, which are reproduced to twice the scale of the others, to illustrate the way in which the head is relieved below the valve seats to encourage swirl





The vertical section FF and the horizontal section JJ are indicated respectively on the plan and elevation at the top of this page. They both illustrate porting details

Water pump and cooling system

The water pump is of the conventional centrifugal impeller type bolted to the front wall of the cylinder block. It is driven in the usual way by V-belt in conjunction with the fan. The flanged boss of the belt pulley and fan unit is fitted with a Woodruff key on the forward end of the En 3B impeller spindle and retained by a plain washer and a self-locking nut. An engine:pump speed ratio of 1·335:1 has been adopted.

Both the water pump body and the 3·115 in diameter rotor are of cast iron. The rotor is pressed on to the rear end of its spindle. Two single-row shielded ball bearings, separated by a sleeve, carry the spindle and are packed with grease on assembly. The water seal is a spring-loaded moulded-rubber unit, with a carbon thrust ring which bears against the front end of the rotor boss. In front of this seal is a brass thrower ring, and a drainage hole is drilled below it in the casting. Two felt oil seals are also fitted to protect the bearings. One is between the rear ball race and the pump body, and the other surrounds the boss of the fan-pulley flange.

Water drawn from the bottom of the radiator is delivered by the pump into the jacket surrounding the cylinders. It then goes up through passages into the cylinder head, and is returned to the radiator by way of a thermostat unit bolted to the front of the cylinder head. This thermostat is set to begin to open at 156-165 deg F and to be open fully at 185 deg F. The cooling system is pressurized at 4 lb/in².

Oil pump and lubrication system

A gear type oil pump, with helical gears, is partly submerged in the pressed steel sump whose capacity, together with that of the filters, is 17 pints. The neck of the cast iron pump body is spigoted into a boss in the base of the crankcase. A spiral gear on the camshaft drives the pump. The driving gear, of cyanide hardened En 32B, is pressed on to the upper end of the En 43C spindle, and secured by a rivet. A thrust washer is interposed between this gear and the neck of the pump body. The driving spindle is carried directly in the bore of the pump body and both the spiral driving gear and the bore in which the upper end of the

spindle bears are positively lubricated from the pump through oilways in the pump body and in the crankcase. Thus the spiral gears receive a supply of oil immediately the engine starts.

In the pump, the En 1A impeller-gears are 1·560-1·559 in long and 1·7720-1·7705 in diameter. The driving impeller is pressed on to the lower end of the spindle and held by two Woodruff keys, while the driven gear rotates on an En 32B spindle hardened to Rockwell C61 and pressed into the pump body. An end cover, secured by six set bolts, encloses the pump chamber.

A transverse drilling in the pump body forms an oilway and is fitted with the oil pressure relief valve. Ports on opposite sides of the pump gears are connected to this oilway; that on the suction side of the pump recirculates the oil that passes through the relief valve. On the delivery side, the outlet of an oilway communicates with a pipe leading to a vertical drilling on the left-hand side of the crankcase. This drilling in turn is connected to the inlet side of an AC-Delco full-flow filter unit.

The filter is bolted to the side of the engine. It has a renewable paper disc element, contained in a detachable casing. A spring-loaded ball-valve incorporated in the head of the unit allows oil to by-pass the filter element should it become choked.

After filtration, oil passes to the main gallery running longitudinally through the crankcase. Drillings in the crankcase webs take the lubricant to the journal bearings, and thence it goes through oilways in the crankshaft webs to the crankpin bearings. The timing gears are fed from the front main bearing through a hole in the bearing and the bearing cap, and the idler gear is individually lubricated from one end of the main gallery. An oilway drilled in the foremost of the intermediate camshaft bearings is connected once every revolution with a vertical duct through the cylinder block and head. One end of an inverted U-shaped copper pipe is pushed into the top of this duct and the other into a radial hole in the rocker shaft. Holes in the rocker shaft communicate with annular grooves machined in the rocker bushes, and oil escapes through holes in the top of the rockers to the end pads and valve stems. Surplus oil drains back to the sump, lubricating the push rods, tappets and cams.

Hermetal Double Bond

A New Filler for Metal Components

HERMETAL Double Bond is a filler that has been developed by The Kenilworth Manufacturing Company Ltd., of West Drayton, Middlesex. It is said to be suitable for use instead of lead for concealing body joints and making repairs to sheet metal components. The advantages claimed for the material are as follows. It eliminates the danger of lead poisoning, and the dust-cloud effect, during sanding, is minimized. In neither of its two forms is the material toxic. Surface treatment of the metal to be filled is confined to the usual measures to ensure that the junction is clean and dry before application of the filler.

The material can be ground, filed, tapped, drilled and sanded to a feather edge without danger of cracking, flaking or blocking. It will take any kind of paint or cellulose and can be stoved. Another important feature of the material is that it is unaffected by contact with hydrocarbon oils, all petroleum products, alcohol, weak mineral acids and alkalis, synthetic detergents and a wide range of organic solvents. The material is also light, and the manufacturers state that it is dimensionally stable. Application of the filler is easy, and there is no evidence that it will promote dermatitis. As is common with fillers of this type, a barrier cream is sufficient to ensure freedom from discomfort.

In addition to application to sheet metal fabrications, the material can also be employed for joining and sealing polyester-glass-fibre constructions such as jigs, pipework and fabricated vessels. Savings in time and cost might be made in the tool and pattern room by the application of Hermetal Double Bond to the construction of work and tool holders, and to experimental or short-run patterns and jigs.

Two grades of the filler are available: one is a cream, and the other is a putty. The cream is for spreading over large areas, or as a surfacer, while the putty is for filling, forming or moulding in depth. However, it has been found in practice that either can be used for almost all applications.

Both grades are combinations of reactive resins, Epikote-amine, mixed with mineral or metallic fillers. The type and amount of filler determines whether the material is in cream or putty form. Both grades are packed in two inert parts, and no reaction takes place until these are mixed. One of the constituents is metallic grey and the other is off-white. This makes it easy to see when the mixing is complete; inadequate mixing leads to ineffective curing.

The putty can be mixed in the hands in the same way as ordinary glazing putty and can be washed off without difficulty. In cold weather, mixing can be facilitated by warming to a temperature not exceeding 120 deg F. Care should be taken to avoid contamination. The cream should be mixed on a clean surface with a spatula or knife.

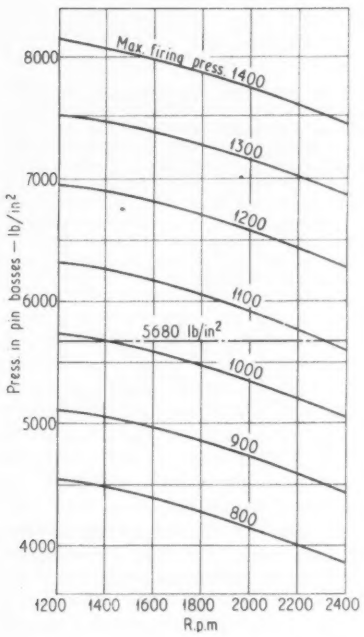
Preparation of the surface to be treated can be confined to degreasing with a suitable solvent, although light sanding is preferred. Other special treatments such as chemical etching are not essential. When the filler is applied, its surface can be brought almost exactly to the contour required, provided the tool is wetted with liquid soap to prevent drag, or roll-off. For moulding, or any application in which the finished work has to be removed from a surface, a release agent must be spread on the surface before the mix is applied. Oil, waxes, silicones, or any of the recognized release agents can be employed. Tools and mixing surfaces must be cleaned immediately after use, because the residues are extremely difficult to remove if left to harden. The uncured material can be removed from hands and tools by the use of white spirit or other similar solvents.

As soon as the two constituents of the filler are mixed, curing starts. However, the reaction is relatively slow at normal room temperatures. At these temperatures the useful life of the mixture, in the container, is three to four hours; the full cure to maximum hardness takes 15-24 hours. However, the curing time can be reduced considerably by raising the temperature. At 120 deg F, both the putty and the cream can be cured in approximately 5-10 minutes.

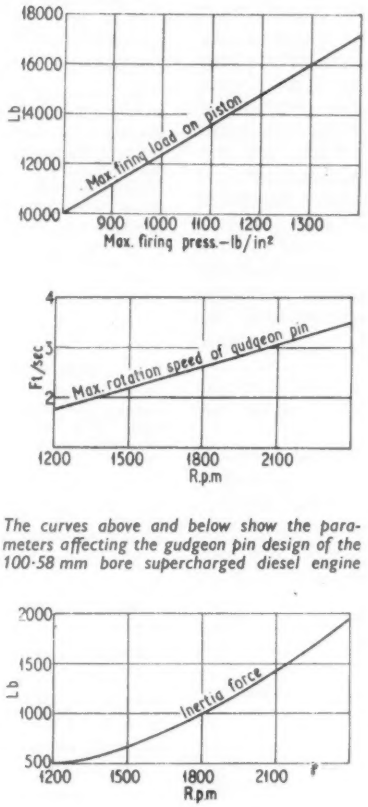
Gudgeon Pin Loading

A Method of Design in Which Gas Load, Inertia Forces and Rubbing Speeds Are Taken into Consideration

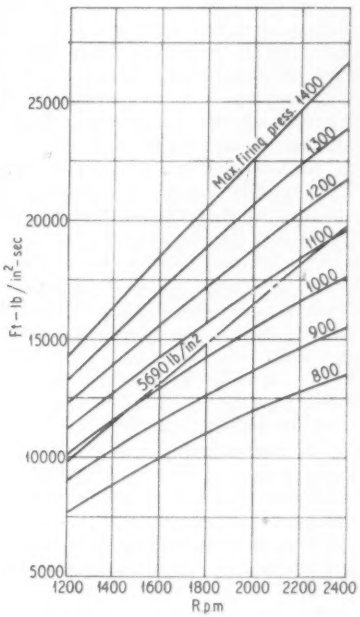
T. O. HUNT*



Bearing pressures of the 100·58 mm bore supercharged diesel engine. The figure of 5,680 lb/in² has been widely regarded hitherto as the maximum permissible bearing pressure



The curves above and below show the parameters affecting the gudgeon pin design of the 100·58 mm bore supercharged diesel engine



Bearing design factor λ plotted against speed of the 100·58 mm bore supercharged diesel engine. The chain-dotted line represents the safety limit calculated by the earlier method

HITHERTO, so far as strength and stiffness are concerned, gudgeon pin design for diesel engines has generally been determined by two considerations. The first of these is the load-carrying capacity of the bearings and pin, based on the projected bearing areas of the pin in the piston bosses and small end bush, while the second is the ability of the pin to resist deflection from its truly circular shape. In determining the forces on the pin, it has been the usual practice to consider only the gas loads, no allowance whatsoever being made for either the inertia force or the additional loading due to the rotation of the pin. A figure of 5,680 lb/in² is widely regarded as the maximum permissible bearing pressure, while a deflection of 0·001 in, irrespective of the length or diameter of the pin, is generally quoted as being the maximum permissible deformation.

Although, in the past, these empirical criteria may have been satisfactory for slow-speed engines operating on low ratings, they are no longer adequate, because of the current engine design trends, such as increased speeds and gas loadings, and reductions in weights of engines per unit of power output. These considerations have led to the employment, for design purposes, of a factor in which the dynamic as well as static loadings are taken into consideration. This factor is designated λ in the discussion that follows, and its units are ft-lb/in²-sec. Of these units, the lb/in² represents the maximum bearing pressure and the ft/sec is the peripheral speed of the pin relative to its bearings in the piston bosses.

It is unfortunate that the angular speed of the connecting rod occurs at the top and bottom dead centres and that at top dead centre on the firing stroke the gas pressure is a critical factor so far as gudgeon pin design is concerned. The rotational speed of a fully floating gudgeon pin is influenced by the engine speed, stroke, centre-to-centre distance between the big and small ends of the connecting rod, and the diameter of the pin.

Many new engines for road vehicle application, including some that are either at the drawing-board stage or still undergoing prototype development, operate at substantially higher speeds than units of earlier design. Moreover, there is also a trend towards the employment of shorter connecting rods to reduce the overall height of the engine and to enable a higher output to be obtained for a given weight. It follows that there is a tendency for gudgeon pins

*Managing Director, Specialloid Ltd.

to become more heavily loaded in each successive design.

If the pin is clamped in the eye at the small end of the connecting rod, its rotational speed C can be determined from the following expression:

$$C = \frac{S}{L}\,\frac{2\pi nR}{60}\text{ft/sec}$$

where R is the crank radius, n the rotational speed of the crankshaft, S the radius of the gudgeon pin, and L the centre-to-centre length of the connecting rod. The peak load on the pin is the resultant of the gas pressure and inertia force at top dead centre. Fortunately, at this point of the cycle, these forces are opposite in direction.

As a result of a trend towards increased specific power outputs, designers have had to provide for increased heat flow from the crowns of the pistons and ring belt sections. This, of necessity, has increased the weights of the pistons. Consequently, it is now essential to take into consideration the relief afforded by the inertia force, otherwise the design calculations are misleading to such an extent that they may call for the employment of unduly large gudgeon pins.

At top dead centre, the piston acceleration is dependent upon the rotational speed of the engine, the stroke, and the centre-to-centre length of the connecting rods. The acceleration, and therefore the inertia force, becomes greater as the operational speed of the engine becomes higher and the centre-to-centre length of the connecting rods is reduced. All the factors previously discussed can be summarized as follows:

The maximum gas load $F = pA$, where p is the maximum firing pressure in lb/in², and $A = \pi D^2/4$, D being the bore of the cylinder in inches.

The inertia force $K = M\alpha$, where M is the mass, which is the weight of the reciprocating components in pounds, divided by the gravitational constant in ft/sec², and α is the acceleration.

Thus, the resultant load $P = F - K$ lb and the maximum pressure f on the projected area a of the pin in its bosses is $f = P/a$.

From the foregoing considerations, the design factor λ can be determined. This factor is defined as:

$$\lambda = Cf \text{ ft-lb/in}^2\text{-sec.}$$

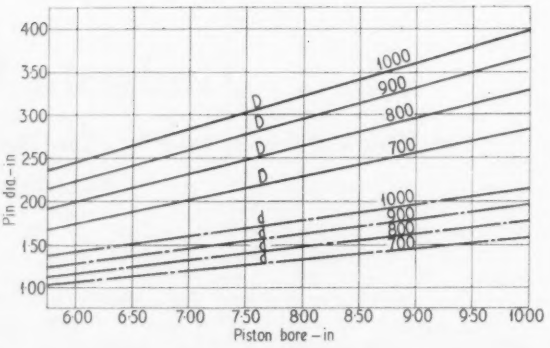
For a fully floating gudgeon pin, this formula should be modified to:

$$\lambda = 0{\cdot}6\,Cf \text{ ft-lb/in}^2\text{-sec.}$$

The constant 0·6 is introduced because, in general, about 60 per cent of the rotational movement of the small end eye relative to the piston takes place between the pin and the bosses, while only 40 per cent occurs between the pin and the small end bush in the eye of the connecting rod.

Investigations have been carried out on a diesel engine, with a bore of 100·58 mm, to confirm the validity of this design criterion. The results of these tests and personal experience over the last three or four years indicate that the factor λ should not exceed about 22,500 ft-lb/in²-sec for conventional gudgeon pins working in light alloy piston bosses. If this loading is exceeded, the bearing surfaces should be pressure-lubricated and in some instances, for example, in two-stroke engines, the bosses have to be bushed.

Of course, it is still necessary to take deformation into consideration. Some authorities maintain that the figure of 0·001 in deflection from the truly circular form should not be exceeded, regardless of the size of the pin, but the Author has found from experience that pin size does affect the allowable degree of deflection. The recommended maximum deflections are: for pistons of less than 65 mm diameter, 0·00075 in; for pistons of between 65 mm and 110 mm diameter, 0·001 in; for pistons of from 110 mm to 160 mm diameter, 0·00125 in; and for larger pistons, a deflection of 0·0015 in can be regarded as acceptable.



These curves are the basis for the design of gudgeon pins to restrict deformation from the truly circular section to within acceptable limits. The outside diameter of the pin can be determined from the curves D, while the inside diameter is given by the curves d, the figures 700, 800, 900 and 1,000 representing the maximum combustion pressures in lb/in². These curves, which hold good for cylinder bores of from 4 in to 8 in diameter, should be used for the initial size-determination, which may be modified subsequently to limit the value of λ to a maximum of 22,500 ft-lb/in²-sec. They are based on the method of calculation described in an article entitled "Gudgeon Pin Design," in the June 1954 issue of Automobile Engineer

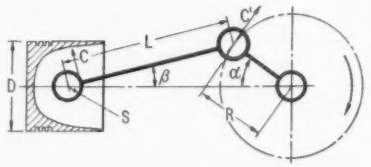
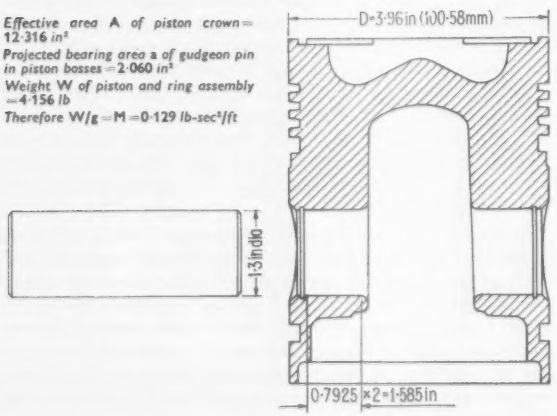


Diagram of crank and piston mechanism, showing the dimensions used in the calculations

The piston of the supercharged diesel engine on which the tests were made, giving the results on the curves on the previous page


Effective area A of piston crown = 12·316 in²
Projected bearing area a of gudgeon pin in piston bosses = 2·060 in²
Weight W of piston and ring assembly = 4·156 lb
Therefore W/g = M = 0·129 lb-sec²/ft
D=3·96in (100·58mm)
1·3in dia
0·7925 ×2=1·585in

Metal Industry Handbook

THE *Metal Industry Handbook and Directory* for 1957 is now available. This issue has 536 pages and is divided into four sections. The first section deals with the general properties of metals and alloys. Section II is devoted to general data and tables; Section III to electroplating and allied processes; and Section IV to a directory for buyers. A complimentary copy of this work is issued to all subscribers to *Metal Industry*. Others can obtain copies, 15s. net (by post 16s. 6d.) from Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Pearlitic Malleable Iron Crankshafts

Developments for the Pontiac V-8 Engine

PEARLITIC malleable iron is a generic term used to differentiate such metal from the older and better known standard malleable iron. The matrix of pearlitic malleable iron is essentially pearlite or martensite decomposition products, while the matrix of standard malleable iron is predominantly ferrite. All pearlitic malleable iron is produced from white iron castings and subsequent thermal treatments convert the white iron into pearlitic malleable iron.

Three different methods of production are today used in U.S.A. One method utilizes alloy additions (such as manganese) in the melt. Such additions, employed in conjunction with suitable section size, annealing practice, etc., result in a microstructure of temper carbon in a matrix of pearlite and spheroidized cementite. Another consists in reheating ferritic malleable iron above the critical temperature, then quenching and tempering. This practice results in a structure of temper carbon in a matrix of tempered martensite. A third method consists in adjusting the annealing cycle to control the degree of graphitization. Coupled with air cooling and tempering, this process results in a structure of temper carbon in a matrix of pearlite.

Physical properties of the pearlitic malleable irons mentioned vary according to the foundry practice and treatment employed. Table I lists range of physical properties which are associated with commercially available castings.[1,2,3] The third method, controlled annealing coupled with air cooling, was used to produce the 1956 Pontiac V-8 Engine crankshaft castings.

The use of pearlitic malleable iron for automotive purposes is not new. Rocker arms, transmission parts, camshafts, etc., made from pearlitic malleable iron have been used for about 20 years, but these parts are all small section-size castings. Recent development of bismuth additions* to molten iron to increase the section-size of castings which can be cast in the white condition, coupled with the development of boron additions to facilitate precipitation of temper carbon, has extended the use of pearlitic malleable iron to include larger section sizes than previously practicable. These developments, in conjunction with recent advances made in shell-moulding techniques, resulted in an investigation into the suitability of pearlitic malleable iron crankshafts for the Pontiac 316 in³ displacement, 8·9 to 1 compression ratio V-8 engine. As a casting this crankshaft would weigh 64 lb, be 2 ft 2⅛ in long and have a maximum section-size of 3½ in.

TABLE I—Physical Properties of Commercially Available Pearlitic Malleable Irons

Ultimate Strength lb/in²	Yield Strength lb/in²	Elongation per cent in 2 in	Brinell Hardness	Modulus of Elasticity lb/in²
65,000 to 100,000	45,000 to 80,000	2 to 10	163 to 269	26,000,000 to 28,000,000

Engineering factors such as modulus, notch sensitivity, etc., as well as manufacturing items such as machinability, tolerances, etc., must be considered when selecting a crankshaft material. All these items, however, resolve into two major considerations. The crankshaft must function properly in the engine and be economically competitive with other materials and practices.

Engineering and metallurgical considerations such as modulus of elasticity, fatigue properties, notch sensitivity, static strength, hardness and wear-resistance of pearlitic malleable iron crankshafts, were recently investigated by Pontiac. The results of these tests were presented to the Society of Automotive Engineers Inc., by K. B. Valentine, assistant metallurgical engineer of Pontiac.

Modulus of elasticity

Test pieces $\frac{3}{16}$ in thick, $\frac{1}{2}$ in wide, and $2\frac{1}{2}$ in long were machined from various positions of finished crankshafts and used for determining elastic modulus. These test pieces were submitted to General Motors Research Laboratories Division, where moduli determinations, utilizing the symmetrically loaded beam-section technique, were ascertained. Table II lists results of these elastic moduli determinations. Each modulus figure listed is the average of two determinations made on a single test bar.

TABLE II—Results of Elastic Modulus Determinations

Specimen Number	Elastic Modulus lb/in²
1	26,200,000
2	24,300,000
3	25,500,000
4	25,200,000
5	26,700,000

When compared with a modulus of 29,500,000 lb/in² for steel, these figures denote a lower modulus for pearlitic malleable iron. In order to obtain maximum machining benefits from a casting made by the shell-moulding process, the pearlitic malleable iron crankshaft design varied from the forged crankshaft design. Consequently, a direct comparison of the effects of moduli on torsional vibration characteristics of identically designed crankshafts is not available.

However, the forged steel crankshaft and the pearlitic malleable iron crankshaft (with design modifications) possess similar torsional vibration characteristics. The appearance of critical vibration cycles at lower engine speed for the pearlitic malleable iron crankshaft can readily be observed. This feature is commensurate with the moduli of the materials involved.

During the first few months of 1956 production, both cast and forged crankshafts were used. To facilitate this dual use of crankshaft material, a harmonic balancer was designed to accommodate both types of crankshafts. With adequate design consideration, the lower modulus of pearlitic malleable iron is no detriment to smoothness of engine operation at normal car driving speed.

Fatigue properties

Dynamometer tests and 100,000-mile car tests showed comparable endurance of forged and cast crankshafts. One year's field experience has substantiated these results. A series of fatigue tests was run to obtain information concerning the effect of notch sharpness on fatigue properties of pearlitic malleable iron. Test bars similar to Izod bars,

*General Motors U.S. Patent No. 2370225.

TABLE III—Results of Fatigue Tests Run on Test Bars with Various Notch Contours

Hardness of Test Bars was 207-217 Brinell	
Notch Radius	**Cycles to Failure**
deg	
10	6,720
10	7,560
10	7,560
10	8,400
20	14,280
20	11,760
20	6,720
20	6,720
20	6,720
20	6,720
20	5,880
30	7,560
30	6,720
30	6,720
30	5,880
30	10,920
30	9,240
30	8,400

except possessing notches of 10 deg, 20 deg or 30 deg, were machined from crankshaft counterweights and used as test specimens for this series of tests. The specimens were subjected to cycles of impact loading by a 3 lb weight dropping 1 in. Results of these fatigue tests are listed in Table III. No effect of variations in notch sharpness on fatigue properties can be discerned.

Tensile strength

Standard A.S.T.M. 505 tensile test bars, machined from journals and counterweights of pearlitic malleable iron crankshafts showed 96,000 lb/in² tensile strength at 228 Brinell hardness. This compares with 114,000 lb/in², obtained on test bars machined from SAE1046 steel forged crankshafts at 228 B.H.N. Pin and journal sections of pearlitic malleable iron crankshafts are reasonably uniform with regard to Brinell hardness. Periodic hardness tests subsequently run on production crankshafts have revealed similar hardness pattern. The Brinell hardness of journal cross-section of forged crankshaft generally was 217-229 from centre to surface.

Wear characteristics

No accurate laboratory tests have been developed by Pontiac which measures the resistance of pin and journal surfaces to wear. Consequently, data presented relative to wear are the result of many different engine tests. Table IV lists results of measurements taken on crankshafts prior to and subsequent to car testing. No appreciable difference in pin and journal wear of cast crankshafts as compared to forged crankshafts can be noted. Measurements taken on main bearings and connecting rod bearings before and after car testing showed that bearing wear was about the same in engines that operated with forged crankshafts as in engines that operated with pearlitic malleable iron crankshafts.

Other items such as type of bearing material and surface finish of pins and journals were controlled during these wear tests. Connecting rod bearings made of lead base babbitt specification GM4195 (10 per cent Sn, 15 per cent Sb) or Durex 100A with GM4167 babbitt (4¼ per cent Sn, 3½ per cent Sb) overlay, functioned satisfactorily with either crankshaft material. Crankshaft main bearings made of Durex 100A with GM4167 babbitt overlay performed satisfactorily with either type of crankshaft material.

Machining Pearlitic

Of paramount importance, when considering crankshaft material, is machinability. Results of large-quantity production runs are the best criteria for determining machining characteristics of a material. The following, which is an excerpt from Pontiac production reports, compares S.A.E. 1046 steel crankshafts with those forged from pearlitic malleable iron. The tests represent two months' production; in one month 59,000 forged steel crankshafts and in another 49,000 pearlitic malleable iron crankshafts were machined.

(1) Operation 10. Tool life increased 56 per cent with castings.
(2) Operation 20. 21 tools required for forgings as compared to 6 tools for castings.
(3) Operation 40. 58 per cent better tool life with castings.
(4) Life of 0·246 in drill increased 147 per cent with use of cast crankshafts.
Life of 0·250 in drill increased 267 per cent with use of cast crankshafts.
(5) Tap life increased 217 per cent with use of cast crankshaft.
(6) Operation 150. 47 wheels used to grind 59,000 forged crankshafts.
27 wheels used to grind 49,000 pearlitic malleable iron crankshafts.
(7) Feed rate of several machines increased.

The crankshaft forging weighed 77½ lb as received and 59½ lb when machined, whereas the casting weighed 64 lb. as received and 54 lb when machined. As can be determined from these weight figures, it was necessary to remove more metal from the forging than the casting.

Supplementary Properties

Data previously presented concerning pearlitic malleable iron were obtained from and are applicable only to, air-quenched and tempered crankshafts as used for 1956 production. In order to obtain additional information, however, it was decided to investigate the effect of other

TABLE IV—Results of Crankshaft Wear Tests

	50,000 Miles (Synchromesh Transmission)		50,000 Miles (Hydra-Matic Transmission)		100,000 Miles (Hydra-Matic Transmission)	
	Min (3 Engines) (in)	Max (in)	Min (5 Engines) (in)	Max (in)	Min (1 Engine) (in)	Max (in)
Crankshaft (Cast)						
Main journal O.D. decrease	0·0000	0·0003	0·0000	0·0005	0·0000	0·0000
Rod journal O.D. decrease	0·0000	0·0005	0·0000	0·0004	0·0000	0·0002
Crankshaft (Forged)	(1 Engine)		(1 Engine)		(2 Engines)	
Main journal O.D. decrease	0·0003	0·0006	0·0002	0·0005	0·0001	0·0004
Rod journal O.D. decrease	0·0004	0·0006	0·0001	0·0002	0·0001	0·0003

TABLE V—Effect of Cold Work on Impact Fatigue Property of Pearlitic Malleable Iron

Treatment	Cycles to Failure
(1) Air quenched and tempered	6,720
	7,560
	7,560
	8,400
Same as (1) above except test bar notch coined 0·001 in	14,100
	42,840
	55,440
	42,000
(2) Oil quenched and tempered	10,080
	11,760
	10,920
	7,560
Same as (2) above except test bar notch coined 0·001 in	14,280
	23,520
	19,320
	11,760

metallurgical practices on this material.

Oil quenching and tempering small section-size parts made of pearlitic malleable iron has been common practice. Consequently, it was decided to investigate the effect of this treatment on some of the properties of crankshafts made from this material.

One of the important factors associated with quenching and tempering a ferrous material is hardening ability. Jominy hardenability bars machined from crankshafts were used to obtain data. Tests indicate that about 1,550 deg F. was the minimum temperature that could be used for quenching pearlitic malleable iron.

Owing to the presence of temper graphite, the Rockwell "C" hardness readings are conceivably of questionable accuracy. However, tests indicated that pearlitic malleable iron possesses good hardening potential for rather large section-size. This characteristic was confimed by hardness survey of crankshafts that had been quenched into oil from 1,600 deg F.

Preliminary investigation into the effects of oil-quenching and tempering of pearlitic malleable iron upon fatigue properties was accomplished with the aid of test bars and the impact-fatigue machine previously described. These tests indicated that for the same hardness level, oil-quenched and tempered pearlitic malleable iron possesses slightly better fatigue properties than air-quenched and tempered pearlitic malleable iron.

Cold work

The effect of cold work on the fatigue properties of pearlitic malleable iron was also investigated with the aid of an impact-fatigue test machine. For these tests, Izod impact test bars were machined with a depth of the notches 0·001 in undersize. Subsequently, the notches were coined in the specified depth. This coining imparted cold work at the bottom of the notch and resulted in a marked increase in fatigue property, as illustrated in Table V.

Based on these test results, crankshafts with the pin and journal fillets cold worked (via fillet rolling) have been made and are on test. The results of these tests are not yet available.

References

1. "Pearlitic Malleable Iron—Interrelation of Heat Treatment, Mechanical Properties and Machinability," John E. Kruse, American Foundrymen's Society Transactions, V–63, 1955.
2. "Comparison of Liquid and Air-Quenched Pearlitic Malleable Irons." American Foundrymen's Society—Preprint 56-84.
3. *Metals Handbook*—1948 Edition, American Society for Metals.

Plastics Exhibition

THIS year the biennial exhibition organized by our associated journal *British Plastics*, takes on, for the first time, an international aspect. Since it was first held in 1951, this exhibition has steadily grown in popularity with both exhibitors and visitors. Because of this, Continental and American organizations connected with the plastics industry have wished to participate, and this year arrangements have been made for them to do so.

The exhibition will be held in the Grand and National Halls, Olympia, London, from 10th July to 20th July. It will be open each day, excepting Sunday, from 10 a.m. to 6 p.m., and will be the largest and most complete exhibition of plastics that has been held in this country. The exhibits will include:—

Materials Chemicals for plastics; resins and moulding materials; and, in addition, such semi-finished products as sheets, rods, tubes and plastic textiles.

Equipment Injection and compression moulding presses, extrusion machines, welding and sealing equipment and moulds will be exhibited. Many of the machines will be shown in action for the production of a wide variety of articles.

Products There will be a vast display of technical mouldings for industry, and of consumer goods.

In addition to a comprehensive coverage of all aspects of the British plastics industry, there will be exhibits from France, Germany, Holland, Italy, Sweden, Switzerland and the United States of America. Concurrently with the exhibition, the organizers have arranged a convention, which will also be held in Olympia. Convention sessions will be held on the 11th, 12th, 15th, 16th and 17th July. On Monday, 15th July, there will be a single session at 2.30 p.m.; on the other days there will be two sessions, at 10.30 a.m. and 2.30 p.m. The subjects to be dealt with by British, American and German authorities are:—

Thursday, July 11th
10.30 a.m. Polyoefins
2.30 p.m. Polythene

Friday, July 12th
10.30 a.m. Polyvinylchloride
2.30 p.m. Foamed materials

Monday, July 15th
2.30 p.m. Extrusion

Tuesday, July 16th
10.30 a.m. Injection moulding
2.30 p.m. Injection moulding

Wednesday, July 17th
10.30 a.m. Material developments
2.30 p.m. Glass reinforced plastics

Season tickets or single-day admission tickets can be obtained from

The Manager,
British Plastics Exhibition,
Dorset House,
Stamford Street,
London, S.E.1.

Applications should be made to the same source for details of, and tickets for, the convention.

Special arrangements have been made for the convenience of visitors from overseas. On presentation of a passport on arrival at the exhibition, an overseas visitor will be given a "visitor's badge," which allows free daily admission.

NEW MACHINE TOOLS

Demonstration of Production Equipment at Sidney G. Jones Ltd.

ESSENTIALLY, the principal elements in factors affecting economic production are machine cycle time and handling time—both of which are dependent upon the best use of available equipment. While it is generally true that the optimum conditions are met by the use of equipment designed solely for a specific operation, the overall efficiency in working is in great measure dependent upon the effectiveness—or otherwise—of the handling part of the cycle. That is, the floor-to-floor time or its equivalent factor. Any improvements in machining time brought about by the introduction of special equipment can be offset, to a large extent, by high loading and unloading times.

Special equipment does, however, lack flexibility, and it is therefore of interest to put on record the results in machining time with standard equipment during a demonstration recently organized by Sidney G. Jones Ltd., 8, Balham Hill, London, S.W.12. The purpose of the exhibition was to show the effectiveness of standard equipment handled by the company tooled for long run production. A particularly interesting machine in this sphere was the Monforts type DA400 hydraulically controlled single-spindle chucking automatic.

This machine, Fig. 1, was tooled for the first of a two-stage operation on Foden front wheel hubs. The hubs which are produced as castings in EN.3 Spec. steel are 15 in outside diameter with a 6½ in in depth pot-section. During the first chucking operation, the hubs are machined to the profile shown on the right of Fig. 2, while the second operation was concerned with machining the outside diameter and face of the pot section. In all, these operations entail facing, fine turning, forming, copy turning, grooving, boring and fine boring. The first chucking requires a time cycle of 16·4 min, and the second 10·7 min, giving a total machining time of 27·1 min.

The DA400 machine is fitted with a 25 h.p. main motor and has a spindle-speed range which is infinitely variable between 18 and 590 r.p.m. in four slightly overlapping steps. Developed from the smaller version of this equipment—type KA200—the new machine has a turning capacity of 16 in on diameter, and 10 in in length. The turret is arranged in the form of a 90 deg opposed-arm cross. This unit is attached to the turret shaft which functions also as the feed piston. Behind the cross is a four-position toolholder drum which slides over the front mounted feed cylinder. The cam disc is mounted on the opposite end of the turret shaft and is used for controlling the indexing movement of the turret. Each arm of the turret cross has a pilot-bush, and during a forward movement of the turret two diametrically opposite bushes in the arms engage guide bars attached to the face of the machine.

The two cross slides are located above the chuck. They are so arranged that they can be adjusted with a fore-and-aft movement in relation to the spindle axis and inclined to allow form turning up to 45 deg. In operation, the cross slide beams are hydraulically locked when the main motor is running to minimize the transmission of vibration or involuntary change in setting.

Fig. 1. Monforts hydraulically controlled single-spindle chucking automatic

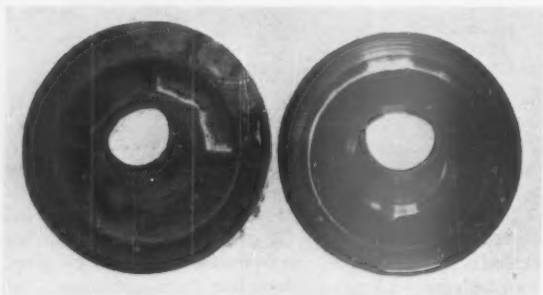


Fig. 2. Foden front wheel hubs machined on the Monforts automatic

All movements of the turret and cross slides are controlled hydraulically, and are arranged with automatic setting trips to give fast traverses for all movements other than actual feeds. Feed movements are infinitely-variable between $\frac{3}{16}$ in and 5½ in/min; the cross slides are provided with a rapid-approach traverse up to within 0·02 in of the feed position.

All the control equipment is at the front of the machine adjacent to the operating position, Fig. 3. As shown, the

control drum is in a readily accessible position above a panel containing the control block. The combined actions of the control block and control drum allow a wide variety of working combinations to be obtained. These combinations include functions such as: starting the cross slide traverses in any position of the turret; combined movements of turret and cross slides; starting the work stroke of the turret by either of the cross slides—and the converse approach; intermediate operation of the cross slide while the turret remains stationary, or skip indexing the turret positions not required for a particular operation.

Although fundamentally a long-run production machine the DA400 can be set reasonably quickly to allow the economical production of small batch runs. For example, the procedure for setting merely entails the adjustment of the control fins and dogs shown in Fig. 3. After the mechanical units are adjusted, all movements and speeds can be controlled by hand while a part is being machined. During the wide facing operation illustrated in Fig. 4, for example,

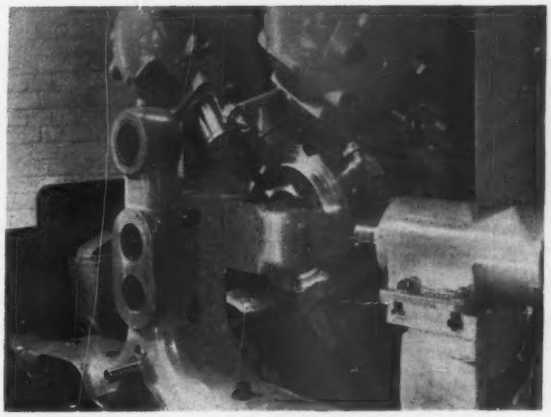


Fig. 4. A wide facing operation on the Foden front wheel hub

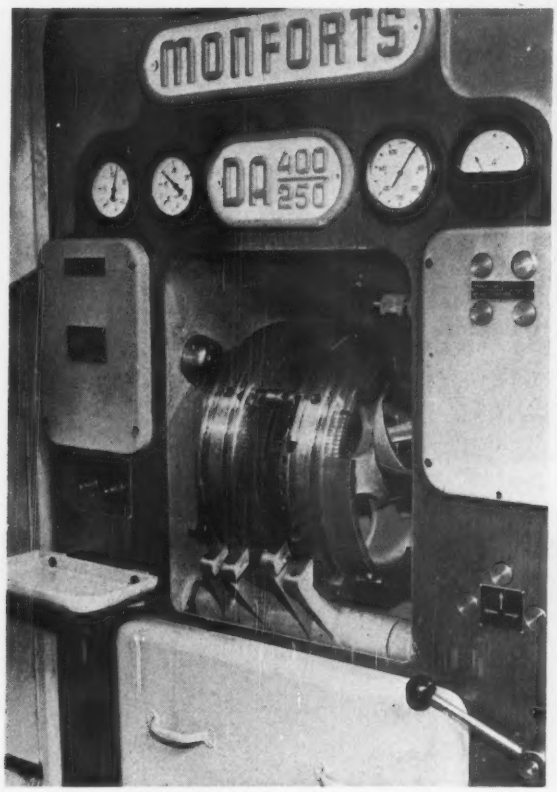


Fig. 3. The control equipment of the machine shown in Fig. 1

the tool is being traversed by the hydraulically actuated supplementary piston on the right which functions as a pusher unit. Here, the tool slide is connected to the pusher unit by means of a bolt connection sliding in a tee slot in the piston rod.

Another component that was being machined during the course of the demonstration, which is of particular interest to the automobile industry, was the production of bull pinions for the Ford Motor Co., Ltd., Fig. 5. These pinions are supplied as forgings to S.A.E.8620 Spec. They are machined in a series of five operations comprising facing and centring; copy turning the entire profile in two operations; the first of which takes in all the contour with the exception of the bearing diameter on the right of the gear which is used for chucking, hobbing, and grinding the bearing diameters. The pinion is 20 in in length, $3\frac{3}{4}$ in O.D. at the gear blank, and $2\frac{1}{2}$ in diameter on the bearings.

The first operation is undertaken as a fully automatic cycle on a Fraser type facing and centring machine, Fig. 6. Here, the part is faced at both ends, drilled and centred at one end and centred at the other. The time cycle for the operation is as follows:

Load and unload	15.0 sec
Fast approach	1.6 sec
Milling	58.0 sec
Fast return	2.85 sec
Centre and drill	60.0 sec

In essentials the machine consists of a rigid bed with parallel slideways on which are mounted two units, each of which comprises a separate face milling head, centring head and vice. The left-hand unit as viewed from the operating position, has transverse motion only and is provided with a location for the workpiece, while the right-hand unit has rapid traverse and fine traverse longitudinal motion for length settings in addition to transverse motion. A work-cycle is made up from a sequence consisting in facing and centring both ends of a workpiece simultaneously, or facing and centring one end and centring the other. Alternatively, the cycle can be abbreviated to either milling or centring.

The machine is electro-hydraulically controlled, by means of limit switches, to produce a sequence of operations in relation to overall control by push-button switching from the console-type panel on the left. The operation sequence is: load the work into the vee-rests—with one end in contact with a positive stop; operate each power-operated vice in turn, withdraw the positive stop and press the cycle-start button for the machining operation.

Each of the milling heads is fitted with a 5 h.p. flange-mounted motor driving a spindle machined in accordance with B.S.S.739 Spec. These spindles can accommodate cutters up to 9 in diameter to operate at a cutting speed of 80 ft/min. The centring heads have quill-feed pattern spindles, the noses of which are arranged to suit collet chucking. Quill movement is controlled hydraulically with a maximum stroke of 2 in in conjunction with a 1 in feed-stroke. Drill speed is 750 r.p.m. min with, from 0-10 in/min feed rate. Fast traverse is constant in both directions at 50 in/min.

The vices are controlled by a separate $\frac{1}{2}$ h.p. motor, and are self-centring units mounted on individual bases which

can be attached to or separated from the transverse slides. They have a clamping capacity for bars between ¾ in and 6½ in diameter with change of setting. In the case of the right-hand vice base, the unit incorporates the mechanism for controlling the movement of the transverse slide. The hydraulic motions are supplied by another independent 2 h.p. pump unit from self-contained equipment which is readily detachable from the machine; transmission is controlled by solenoid-operated spool-type selector valves. The M series machines are made in three bed lengths to accommodate circular section parts of up to 5 ft, 7 ft, or 9 ft in length.

After leaving the facing and centering stage, the pinions are transferred to a Heinemann type D170J/600 copying lathe. On this machine, Fig. 7, the part is copy turned in a

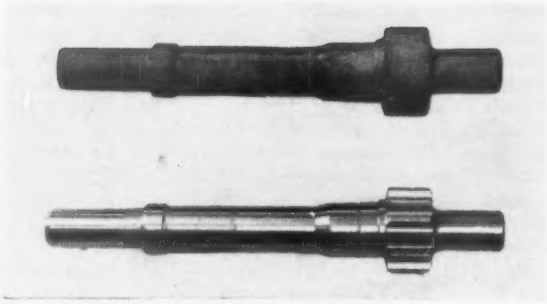


Fig. 5. Ford bull pinions

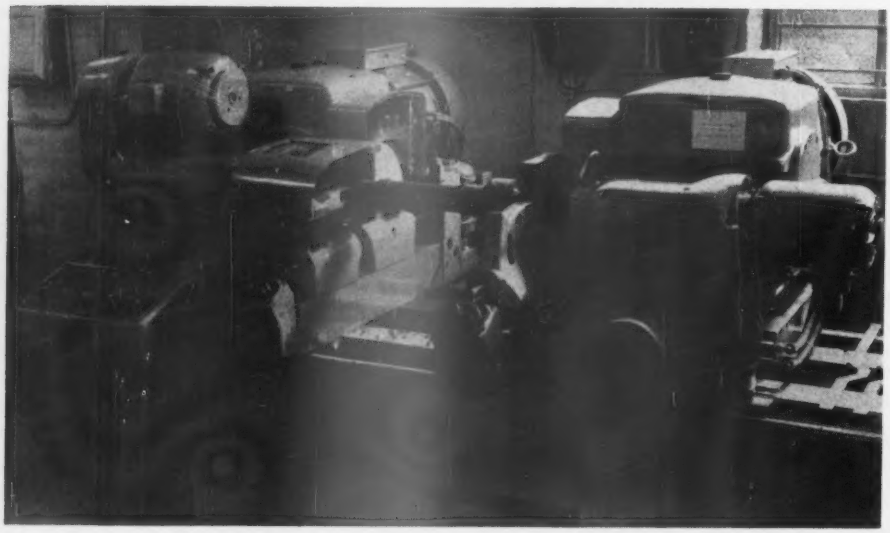


Fig. 6. Fraser facing and centring machine on which the part shown in Fig. 5 is faced at both ends, drilled and centred at one end and centred at the other

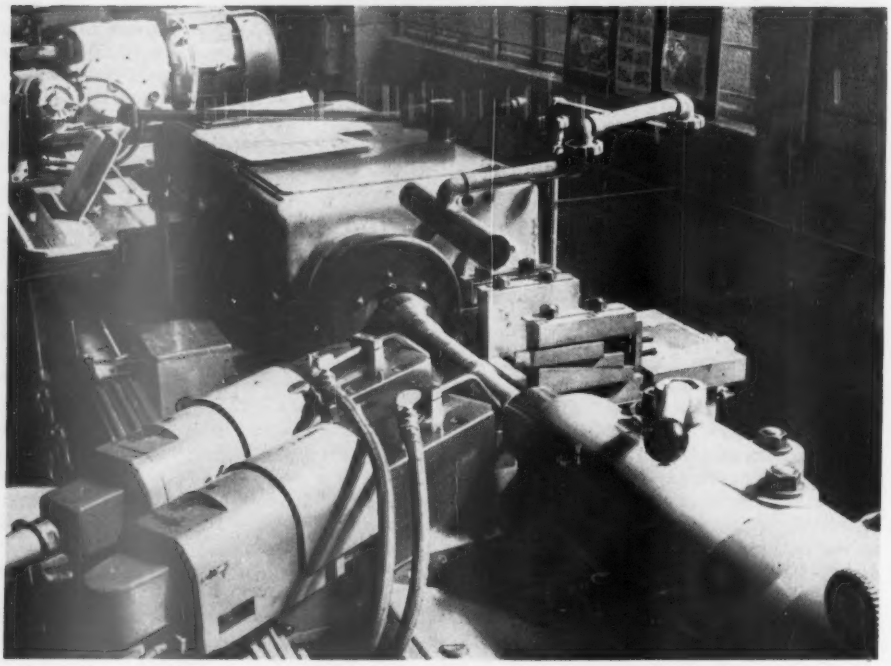


Fig. 7. Heinemann copying lathe. The copying heads are hydraulically operated, and at the end of a machining cycle all carriages and slides are automatically returned to the starting position

four-tool set-up. This entails the complete machining on the long side of the shaft, which is undertaken in a cycle time of 2·35 min. Although the part is loaded manually, the normal handling cycle time is greatly reduced by means of a Pratt work-driver and power-operated tailstock.

Profiling is distributed between two hydraulically-operated copying-heads mounted on the front-slides, while the grooving operations are taken care of by the inverted tools on the rear-slides. The templates for the copying-heads are attached to a longitudinal support-table at the front of the machine. In its standard form, the lathe is fitted with a 15 h.p. main motor, and has eight spindle speeds from 63-710 r.p.m. When required, however, the lathe can be supplied with a 20 h.p. motor and have a spindle-speed range of 90-1,000 r.p.m. or 125-1,400 r.p.m., depending upon the class of operation for which it is to be used. It can swing 13 in over the vees, and handle parts up to 39½ in in length. When set for a production run, all carriages and slides return automatically to the start position at the end of a cycle.

During the course of the demonstration, the remainder of the pinion-bearing surface—on the short end of the shaft—was machined on a Heinemann model RB70 turret lathe fitted with a copying head similar to that shown in Fig. 7. This is a straightforward operation, entailing the turning of a plain diameter and facing the side of the gear out to 3·7 in diameter in a cycle time of 1·9 min.

The gear cutting on the pinions is undertaken on a model S5 Liebherr gear hobber, Figs. 8 and 9, fitted with an intermittent automatic hob-shift giving a movement of up to 0·050 in at the end of an operation. The gear blank is 3·7 in diameter with a 2 in face width; and this is hobbed with 13 teeth to 4 D.P. in a cycle time of 4 min. This machine is fitted with a 5½ h.p. main motor and a 1·2 h.p. rapid traverse motor. Among the principal features of this equipment is the infinitely variable hob speed of between 40 and 200 r.p.m., and infinitely variable hob saddle feeds of 0·008 in to 0·148 in/rev, both of which are indicated on direct-reading dials: these speeds and feeds can be changed while the machine is running under load. Another interesting

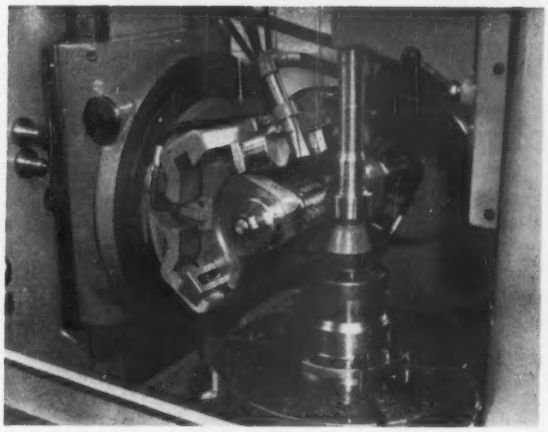


Fig. 9. The set-up on the Liebherr machine for cutting the gear on the component shown in Fig. 5

point is that the machine can be used for climb or conventional hobbing, and in addition when required, plunge feeding with automatic changeover to climb-hobbing.

The hob-head itself is compact in design and can be adapted to admit hobs up to 6·299 in diameter and 5·188 in in length. This consideration allows a more accurate involute form to be produced, and by presenting a flatter circumferential curve permits a greater feed to be used as the inevitable feed-marks are reduced. Special gearing is used for the index-worm drive which, as standard, has a single-start worm. Two axial adjustments are provided for the worm, with the view to obtaining the minimum practicable amount of backlash and end clearances. After preliminary setting, the machine is controlled entirely by push-buttons. During operations, all feed and rapid traverse motions of the saddle are electrically-interlocked, and as a further safety factor, a system of warning lights is used to indicate the progress of the operation.

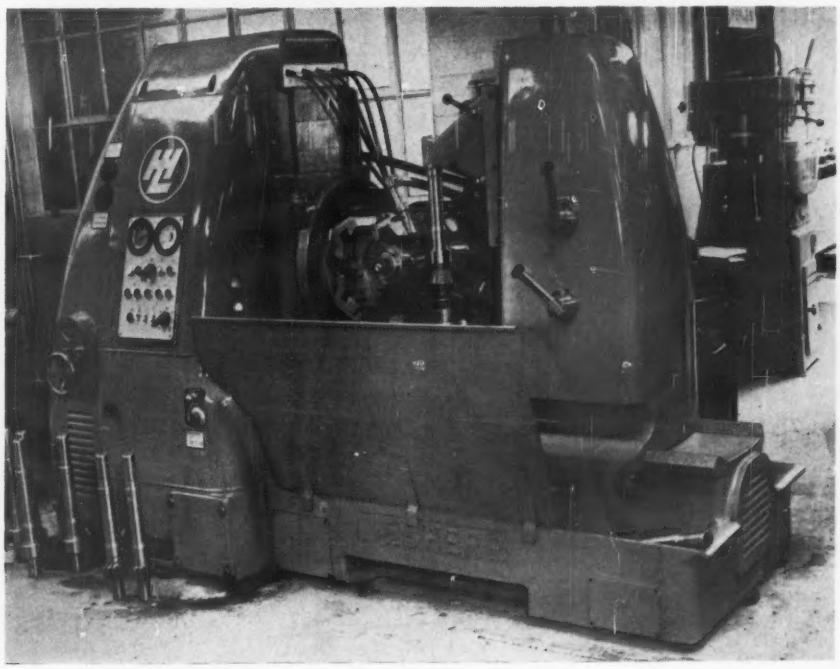


Fig. 8. Liebherr gear hobber. This machine has infinitely variable hob speeds and hob saddle feeds. The speeds and feeds can be changed while the machine is running

Continental Coachwork

A Review of Current Trends and Some Interesting Features of the Latest Models

ONE of the most noticeable trends evident among the products of the Continental coachbuilders is the emphasis placed on the waist-line by extending it to the extreme front and rear ends of the vehicle. The extension to the rear generally takes the form of a relatively thin-section fin produced by elevating the crown of the rear wing, or quarter panel, while the forward extension has been obtained in many instances by pressing a line along the crown of the front wing, from the scuttle to the headlamp. The overall effect of these features is to emphasize the length of the vehicle.

The wrap-round windscreen arrangement is becoming more widely adopted, although the coachbuilders do not appear to have accepted it very enthusiastically. If the wrap-round is too exaggerated, it is difficult to harmonize with the general lines of the vehicle, because of the forward rake of the screen pillars. Moreover, the problem of wiping the wrap-round portion in wet weather still remains to be solved. With most vehicles that incorporate this feature, the unwiped area of the screen can be a dangerous obstruction in the field of vision.

It is not surprising, therefore, that many of the coachbuilders, while pandering to fashion by adopting the wrap-round screen, have nevertheless restricted the degree of wrap-round. In any case, spacial restrictions, inevitable in the small cars of European design, preclude the adoption of the exaggerated degree of wrap-round common on American cars. Even with a limited wrap-round, it is in some instances necessary to be careful to avoid knocking the knee on the lower corner of the screen pillar when entering the front seats of the car.

With regard to front end styling, there is a marked trend towards lowering the bonnet lines. This is difficult with bodies built on European chassis, which nearly all have vertical in-line engines. Since V-type and horizontally-opposed cylinder units are currently regarded as too expensive for quantity-produced cars, it is unlikely that there will be any appreciable alleviation of this difficulty in the near future. Nevertheless, some improvement may be obtained by the employment of carburetter and air cleaner arrangements that do not add so much to the overall height of the power unit.

A measure that has been taken by the coachbuilders to obtain lower bonnets is the incorporation of an air intake duct in the centre of the lid; in some instances, this duct is simply a dummy, because its sole function is to provide clearance for the carburetter and air cleaner. A merit of this arrangement is that in addition to allowing the general level of the bonnet lid and its surround to be lowered by an inch or more, it also breaks up what would otherwise be a plain area and stiffens the lid. The principal reason for the lowering of the bonnet line is to improve the forward vision. It also enables the driver to have a view of both front wings and thus helps him to estimate more accurately the clearance between his vehicle and obstructions on each side.

The lowering of the bonnet line has inevitably led to the widespread adoption of the horizontally elongated form of radiator air intake opening. These openings are in most

This is the Pinin Farina Florida, from which the body of the Lancia Flaminia, illustrated below, was developed. It is of interest to compare the two, and to observe the modifications that had to be effected to make the body suitable for quantity-production by the firm of Lancia.

The Lancia Flaminia is a good example of the application of the specialist coachbuilder-and-stylist's art to a body designed for quantity-production

instances more or less rectangular in shape. Variations to give individuality of treatment are made not only in respect of the proportions of the rectangle but also by the use of different types of grille in the opening and the incorporation of horizontal chromium plated bars. Two forms of grille are extremely popular. One is a relatively large mesh, formed by horizontal and vertical strips of aluminium slotted and interlocked at their intersections. Another, of extremely simple and inexpensive construction is a relatively thin sheet of aluminium pressed into deeply corrugated form, the corrugations running from side to side of the grille. The crowns of the corrugations generally represent the horizontal bars of the grille and the valleys have rows of rectangular holes punched in them, the metal left between the holes representing the vertical bars. In some applications, however, the sheet is arranged so that the crowns of the corrugations represent the vertical bars.

With these low bonnet arrangements that are now so popular, it is practically impossible to incorporate the traditional vertical type of radiator grille. However, since this type of grille has, for many years, been such a distinctive feature of many of the chassis, some manufacturers have been loth to abandon it altogether. Therefore, the coachbuilders have devised shields to represent the shape of the traditional radiators of these manufacturers, and have mounted them either on the grille in the radiator air intake opening or on the front of the bonnet surround panel. In general, the modern European designs are noteworthy for the absence of fussy chromium plated ornamentation.

Two views of the Renault Dauphine by Allemano. From the three-quarter rear view it can be seen that the outline of the panel between the rear wing cutting line and the air intake opening is almost a mirror image of that of the rear quarter of the canopy

The rear end styles that have been exhibited recently have shown a marked trend towards greater simplicity. Almost all the coachbuilders now employ the fin type rear wing layout, which is said to improve aerodynamic stability. The arrangements adopted are in general based on one of two themes. The first of these is the tail feathers of an arrow, or perhaps the fins of a rocket projectile, while the other is the raked tail unit arrangement common on supersonic aircraft. In adopting this type of design, the coachbuilders have aimed at giving an impression of sleek, high-speed efficiency.

Interior styling continues to show marked improvements, despite the fact that harmony of line is so difficult to attain in such a confined space, cluttered up with the steering wheel, seats and other impediments. In general, the aim with regard to the styling of door trim is at blending its lines with those of the seats and dash facia, while at the same time presenting a self-contained and well balanced design when the door is viewed by itself, that is, in the open position. There appears to be no unanimity with regard to dash facia styling. However, in cars in which low lines are the predominant feature, it is logical to see a facia that accentuates

Vertical features are prominent at the front of the Fiat 1100 TV model, the front end of which has been styled not as a separate entity, but to harmonize with the arrangment of the body sides

the horizontal lines. The grouping of instruments on a deep rectangular panel does not seem to be in keeping with this theme. In the past there has been a tendency for the facias of high-speed sports cars to be crowded with instruments of all sorts. While this might appeal to some of the mechanically-minded enthusiasts, it would appear that simplicity of arrangement is far more desirable for the serious racing motorist. At high speeds, the driver's attention is inevitably directed mainly towards the road; in attempting to take in at a quick glance the readings of too many instruments, he is liable to miss important indications of one or other of the vital ones.

It is, perhaps, not well known in this country that Fiat have a specialist coachbuilding works among their many establishments in Turin. The illustration showing the body for the Fiat 1100 TV is of interest because it was made at these works and is, therefore, representative of a large manufacturer's conception of specialist coachwork design. This model incorporates a wrap-round windscreen. On each side, the lower edge of this screen forms a continuation of the crown line of the front wings. The trailing edge of the wrap-round is about 14½ in behind the leading edge of the door. Wide chromium plated capping strips are fitted over the pillars and the head rail.

Another feature of the design is that the front end is styled in such a manner as to harmonize with the arrangement of the sides of the vehicle rather than as a separate entity. This has been effected in the following manner. Over-riders are incorporated at the extreme ends of the front bumper. These over-riders, which are turned under the body panelling, point upwards to the headlamps, and torpedo type side lamps are mounted flush on the wing crowns. Thus, on each side there is a continuous line extending from the wheel centre, forward and up the over-rider, over the centre of the headlamp, along the wing crown, through the side lamp and then falling along a line through the base of the wrapped-round side of the wind-

screen. At the rear of the door, this line sweeps up with the rear wing crown and falls gently again to the tail end, where it drops through the tail lamps to another over-rider, which, like that at the front, is wrapped under the body. At the front a direction indicator lamp is housed in the top of each over-rider.

A central, vertical pillar divides in two the elongated rectangular grille, each half of which has a chromium plated finisher strip round its edges. The vertical line of the pillar is continued by a ridge pressed in the panelling above it, and extending along the longitudinal centre-line of the bonnet lid. A chromium plated, elongated winged motif is mounted on the crown of this ridge at the front of the bonnet lid.

Allemano

Two noteworthy features of the Allemano body on the Lancia Series 2 chassis are the slender pillars of the windscreen and rear quarters, and the arrangement of the well defined lines pressed in the body panelling. There are two lines pressed in the bonnet surround, one on each side, parallel to the edge of the bonnet lid. On each side of these, the front wing crown line is also a well defined line that extends along the waist to merge into the crown lines of the rear wings. A horizontal chromium plated strip extends the whole length of the vehicle between the headlamps and tail lamps. Another chromium plated strip is fitted along the longitudinal centre-line of the bonnet. All these features tend to accentuate the length of the vehicle.

The radiator air intake is of the popular elongated rectangular form. A Lancia shield is mounted in the centre of the horizontally corrugated grille. The windscreen has a small wrap-round portion at each side and the rear light is also of the panoramic type. Chromium plated finisher strips are fitted round all the windows, and a continuous strip extends along the waist on each side and across the scuttle and the junction between the canopy and rear decking. Because of the exceptionally slender pillars, the all-round visibility is good.

Allemano also manufacture a special body based on the Renault Dauphine chassis. It is a fixed-head coupé, a style that is greatly favoured by coachbuilders, because of the ease with which it can be adapted to give smooth flowing lines that are a credit to the designer. With four-seater bodies, of course, the need to provide adequate headroom at the rear seriously hampers the stylist.

At the front, the headlamps and direction indicators are mounted one above the other, the spot lights being fitted in dished apertures in the skirt panel just inboard of the direction indicators. A chromium plated spinal strip is fitted on the longitudinal centre-line of the bonnet lid. It is arched at its forward end to form a handle immediately behind the push-button bonnet lock. A horizontal chromium plated strip extends from the top of the front wing cutting line, over the rear wing cutting line and almost to the rear lamps.

An engine air intake, with chromium plated finisher strips on its edges, is incorporated just behind the door shut line on each side. The edge of this intake is approximately parallel to the rear edges of the front and rear wing cutting lines, and also to the sides of the rear light. The door shut pillar is raked in the opposite direction, as also is the screen pillar. The harmony of line achieved by this arrangement can be seen better in the illustration of the three-quarter rear view of the vehicle than in the three-quarter front view. It can be seen that the panel between the rear wheel arch and the air intake is almost a mirror image of the rear quarter panel between the side and rear lights.

Two tear-drop shapes on the lid of the engine compartment at the rear provide clearance for the highest parts of the engine installation. They also serve to break up the plainness of the lid, and enable the profile to be dropped steadily to the rear, where there is an elongated rectangular opening, like a radiator air intake. The rear quarter panels are shaped to form the rather rounded type of fin that has been common until now, but which is rapidly being replaced by thinner section fins with raked trailing edges.

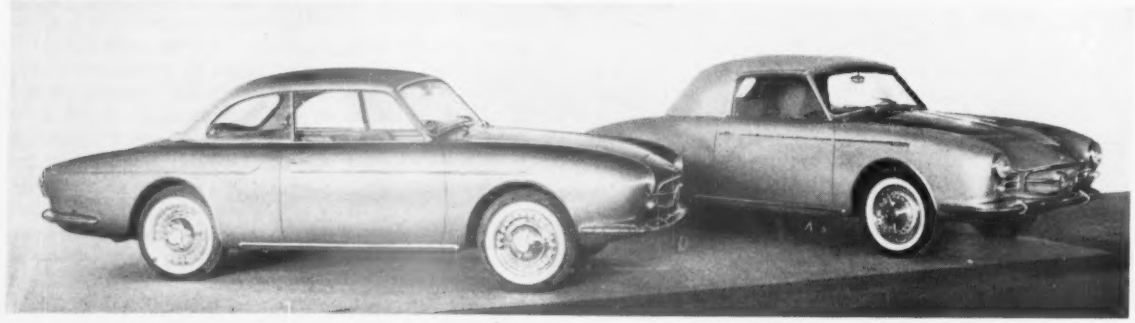
Beutler

Beutler produce several well proportioned bodies on the Porsche chassis. Among them are the drop-head and fixed-head four-seaters. As can be seen from the illustration of these two models, the styles are in general identical, except that there is no chromium plated strip on the rear quarter of the drop-head model. Three-piece, wrap-round bumpers are fitted at both the front and rear ends of the cars.

Both of these rear engine models have an imitation radiator air intake at the front. The bonnet top is swept downwards towards the front to give a good range of forward visibility. Immediately over the imitation air intake, the leading edge of the bonnet surround panel is overhung about ¼ in. The line formed by this overhang is swept up on each side and tapers-out over the headlamps. This line, together with a bar that divides the radiator air intake horizontally, helps to accentuate the width of the car. Its upturned ends are balanced by the down-turned ends of an extension of the horizontal bar across auxiliary intakes on each side of the main one. These upward and downward swept lines blend smoothly into the elliptical form of the body side. All the chromium plated finisher strips and bars at the front end are of light section.

The whole design of the cars is based on a series of ellipses. The imitation air intake at the front is elliptical in form; as can be seen from the illustration, the body side from the waist downwards is basically another ellipse; and, again, the side lights of the saloon are almost of the same form. The bumpers also are designed in conformity with this general theme, since they are of semi-elliptical section.

Beutler drop-head and fixed-head four-seater bodies on the Porsche chassis. The styling of these bodies is based on a series of ellipses; this feature is most marked in the fixed-head model. Note how the lines of the imitation radiator air intake merge with those of the sides

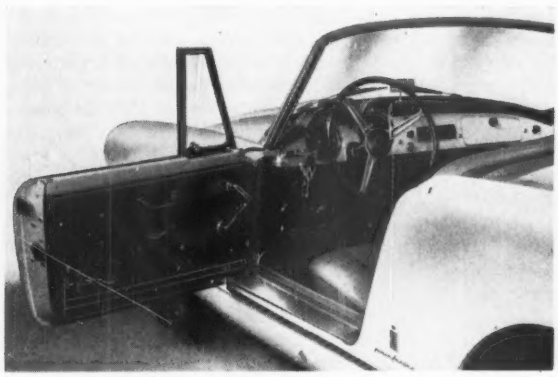


Hitherto Lancia have always insisted that their traditional radiator grille be incorporated in coachbuilt bodies based on their chassis, but because of modern styling trends they are now content to have at the front end a shield representing the grille

However, in contrast, the wing cutting lines are almost true semi-circles, and tend to clash with the overall theme.

A conventional curved windscreen is employed. Its pillars are only 2 in wide as viewed from the driver's seat. The outer panel of each pillar is jointed, without lead filling, both at the top and bottom. On the doors there are no glazing frames above the waist. The rear quarter light has pivots at the top and bottom of its almost vertical front edge, and a toggle type fastener at its trailing edge. An interesting feature of the door locking arrangement is that there are two locating wedges of hard rubber, one at the top and one at the bottom of the door shut pillar. The lock itself is of the

The door of the Pinin Farina Lancia Aurelia presents a pleasing picture as viewed by itself, when open, and also its lines are in harmony with those of the dash and the remainder of the trim



rotary type and a slot in its striker plate engages a nylon faced lug to provide accurate location, without rattles.

Pinin Farina

Pinin Farina is now more concerned with the styling of cars for the manufacturers who produce in large quantities than in the design of one-off models for individual customers. In some instances, it is simply the styling that is done by Pinin Farina, the bodies being produced by the manufacturer concerned, while in others, where the quantities required are smaller, the bodies are made as well as styled by Pinin Farina and delivered to the manufacturer ready for mounting on the chassis. In addition, Pinin Farina has a range of models in series production, but these are generally disposed of through the sales organizations of the firms on whose chassis they are mounted. It follows that this stylist and coachbuilder is accustomed to facing the practical problems involved in manufacture in both large and smal quantities and reconciling them with what is desirable from the stylist's viewpoint.

One of his noteworthy successes in this field is the Lancia Flaminia, illustrated on the first page of this article. It is of interest to compare the Flaminia with the Pinin Farina Florida, from which it is derived and which is also shown in an accompanying illustration. The Florida was described in some detail in the July 1956 issue of *Automobile Engineer*.

So far as external appearance is concerned, only a few changes can be seen on the Flaminia. One is that headlamps more suitable for a quantity-produced car are employed. The bumpers have been modified slightly and the wheel arch arrangement also is different. All four doors are hinged at their front edges. It would appear that the canopy is higher and the windscreen deeper, to give more headroom.

Another body produced by this coachbuilder and based on a Lancia chassis is the B24 Aurelia Gran Turismo, 2·5 litre convertible. It differs from the standard production model made by Lancia in that the traditional Lancia radiator grille is not employed. Instead, a horizontally-elongated, rectangular air intake opening is incorporated in front of the radiator, and the Lancia grille is represented by a small shield on the bonnet surround above the air intake. The rear wing line is also different, being of the now familiar finned form, to give the car a sleek appearance.

A feature of this model is the low bonnet line, which has been attained by the incorporation of an air intake duct on the lid. This not only allows clearance for the carburetter and air cleaner, but also helps to break up the plain aspect of the bonnet. The wing crowns are high relative to the bonnet. This has a useful practical advantage, in that the driver can readily estimate the width of his vehicle. It also avoids the nose-down appearance that is characteristic of so many of the modern cars that have a low bonnet line, and it harmonizes with the high crown lines of the fin type rear wings.

At the rear, the trailing edges of the two wings are raked to resemble the fins of a high-speed aircraft, or of a dart. These raked trailing edges carry the rear, stop and indicator lamps. The bumper section, as can be seen from the accompanying illustration, is such as to tend naturally to over-ride any obstacles with which it might come into contact. A similar section is employed for the front bumper which, like that at the rear, is wrapped round the sides of the body and therefore is made in three pieces. Twin, chromium plated exhaust tail pipes project from underneath the rear of the vehicle. This feature is common among the Continental coachbuilt cars, probably because prominent exhaust pipes are associated with the tail pipes of rocket projectiles and jet engines.

The design is noteworthy for the absence of fussy chromium plated detail. The plainness of the rear end is broken only

The rear end of the Pinin Farina Lancia Aurelia is typical of the modern trend of styling, in that the fin type rear wings are made to resemble the tail unit of a high-speed aircraft, or the fins of a rocket

by the exterior boot lid hinges and catches for the folding hood, which is stowed behind the seats, and a small crossed-flags motif on the boot lid. A pronounced horizontal line is pressed in the skirt panel above the bumper. It is at the level of the lower edge of the boot opening and is swept round the rear quarters to terminate above the leading edge of the swept round portions of the bumper.

The interior styling has been well executed, and a noteworthy feature is the door trim, which not only blends with the general arrangement of the remainder of the interior, but also presents a self-contained and well balanced picture, as viewed by itself, with the door open.

Horizontal features are accentuated on the dash, by painting it in two colours, the dividing line between the two being horizontal. A special matt-finish paint is employed on the top portion of the facia, which is overhung to form a hood over the instruments; both these features tend to obviate reflections on the windscreen. The lower portion of the facia is painted white, as also are the waist rail cappings on the doors. The effect obtained by the use of the black and white paint in this way is to give the facia a wide and slender appearance, which is in harmony with the general lines of this convertible design.

The two, bucket type, seats are exceptionally comfortable and well padded and trimmed with hide. Between them is an upholstered bridge-piece, which fits loosely over the propeller shaft tunnel. This bridge-piece is employed so that the vehicle can be regarded as an occasional three-seater. Both seat squabs pivot forwards to give access to the tonneau.

One of the Pinin Farina vehicles that incorporates a wrap-round windscreen is the coupé body mounted on the Lancia Appia Series 2 chassis. At the front end, the arrangement is not unlike that of the new Lancia Flaminia model. An air intake louvre is incorporated in the bonnet lid to clear the carburetter and air cleaner. This gives a low bonnet line and, therefore, a good range of forward vision.

The more interesting features of the styling are evident when it is viewed from the side. An exceptionally slender hardtop has been obtained by the employment of deep windscreen and side screens, so that the pressing is relatively shallow. The door shut pillar above the waist, and the side pillar of the swept-round portion of the rear light, are so arranged that the rear quarter of the canopy is of V-shape, the point of the V being at the junction between the door shut pillar and the waist line. This V-shape is accentuated by two chromium plated finisher strips; one extends forwards and is continued along the cant rail and the head rail, while the other is carried along the upper edge of the rear light.

From the illustration, it can be seen that the door shut line below the waist sweeps up to harmonize with the lines of the V. The rear edge of the front wing-cutting line is parallel to the forward-raked arm of the V, while the front edge of the rear wing cutting line is parallel to the backward-raked arm, which, in turn, is approximately parallel to the windscreen pillar. To have added another chromium plated strip on the side of this vehicle would have detracted from the well-balanced effect obtained by that on the hardtop. Accordingly, a line has been incorporated in the side panels, at the level of the top of the door sill. This has been done by the employment of the dihedron device, discussed at some length in the description of the Florida model, in the July 1956 issue of *Automobile Engineer*.

At the rear, a fin type rear wing arrangement has been adopted, but although it has a well defined crownline, which is continued over the trailing edge, it is of a more rounded style than that of the drophead coupé previously described. The trailing edge is raked to the rear but as viewed from the side is slightly curved, instead of straight. The profile of the wing crown, as viewed from the side, is also a sweep and the rear lamps are housed behind a glass moulded to

At the front of the Pinin Farina Aurelia an elaborate air intake scoop has been incorporated on the bonnet lid to clear the highest components of the in-line engine installation

the shape of the trailing edge. This arrangement is in harmony with the rounded profile of the rear end of the hardtop. The boot lid extends the full width between the wing panels, which are extended down below the level of the lid and spot-welded to the drip channel on each side.

There are a number of interesting features on the doors. The seals round the pivoted glass ventilating panel in front of the drop glass are of simple form and the panel is easy to open and close. To prevent water from running into the vehicle at the bottom edge of this panel, there is a drip channel mounted on the upper edge of the interior waist rail capping. This channel is drained into the door. Although at first sight this might appear to be an undesirable feature, on reflection it will be found that the amount of water that can enter the door through this drain hole is much less than that which will run down the outer surface of the drop-glass and thence into the door.

On each hinge of the door there is an over-centre spring device, which takes the place of a check stop. It is simply a coil spring loaded in torsion and operates on much the same principle as a spring used on the radiator shutter doors of the Renault Dauphine, illustrated on the first page of an article describing that car, published in the April 1956 issue of *Automobile Engineer*. An advantage of this device is that, in addition to holding the doors in the open position, it assists in opening and closing them.

For a number of years, the Fiat 1100 TV model has been produced in series by Pinin Farina. This year, an entirely new body for this model has been introduced. Whereas the earlier version was primarily a two-seater with two additional occasional seats at the rear, the new one, also a two-door model, is stated to be a four- or five-seater. A bench type seat is employed at the front, but its squab is divided in two, each half folding forward separately to give access to the rear seats. Although the front seats are really only intended for two, they would accommodate three small people.

To make available the maximum amount of knee-room for the rear passengers, the front seat squabs have tubular frames round their edges, and the centre portions of their rear faces are dished in a manner similar to that which can be seen in an illustration of the interior of the Francis Lombardi Fiat. Not only are seats fabricated in this way unusually light but, in addition, the dished portions allow the rear passengers extra knee room.

The additional head room for the rear passengers has, of course, been obtained by raising the canopy. An interesting feature of this arrangement is the rear quarter pillars, which are unusual in that they are slightly tapered, their smallest section being where they join the waist. The taper of these slender pillars and the shallowness of the roof pressing have the effect of lightening the appearance of the upper portion of the car. This effect is enhanced by a narrow chromium plated finisher strip on the drip channel, which extends along the head rail, the cant rails and down the rear quarter pillars to the waist.

At the front, the windscreen has a small wrap-round at each side. The lower edge of each wrap-round portion forms part of the horizontal line of the waist, which is continued to the front and the rear by the crown lines of the wings. A dihedron device, as previously described, is used to break up the plainness of the body side; the apex of the dihedral angle is at the level of the top of the door sill. On the wheels, chromium plated nave plates incorporating imitation solid spokes and imitation knock-off hubs tend to give the vehicle a sporting appearance. Solid spokes are becoming more popular than the wire bracing, because they are easier to clean. Wilmot Breeden door handles are employed, and the Lucas wipers clear all but a small portion of the wrap-round screen.

The front end treatment is rather more elaborate than on most of Pinin Farina's latest creations. A chromium plated finisher strip is fitted round the edge of the radiator air intake opening, which is of elongated rectangular form. Two horizontal bars are incorporated near the base of the opening and between them, at each end, are the direction indicator lamps. Above the centre of these bars is a chromium plated ring with the TV monogram inside it.

The grille background is of interest. It is of the pierced corrugated type described at the beginning of this article, but it differs from those used by most of the other coachbuilders in that the corrugations are of angular instead of rounded section. The flanks of the corrugations are raked at a small angle to facilitate withdrawal from the press, while the crowns are flat and highly polished. Rows of square holes are pierced in the flat valleys.

The rear quarter arrangement of the Pinin Farina Lancia Appia Series 2 hardtop is different from that of the Aurelia, in that it has more rounded profiles

A channel section pressed in the bonnet lid extends from the front and forms a lead-in to the air intake scoop, which, of course, is of inverted channel section. The leading edge of the scoop carries a chromium plated finisher strip. There is no bonnet surround panel, since the lid extends the full width between the wings and its front edge forms the top of the radiator air intake opening. This arrangement is noteworthy because of the relative simplicity of the panel shapes and the ease with which the joints can be concealed.

At the rear, the styling is simple. Elevated wing crowns form fins, in the trailing edges of which the lamps are mounted. These lamps are carried on a chromium plated surround which serves to conceal the panel joints and therefore obviates production difficulties. The boot lid extends between the rear wings in much the same way as the bonnet lid at the front. A full-width rear window gives a good range of visibility; it is overhung slightly by the trailing edge of the canopy, the overhang being less than $\frac{1}{2}$ in.

A noteworthy feature of the latest version of the Pinin Farina Fiat 1100 TV is the tapered pillars at the rear quarters of the canopy. This, together with the shape of the roof pressing, gives the vehicle an exceptionally light appearance

As an example of the modern trend in sports car styling, the Ferarri Spider 300 Gran Turismo can be said to be one of the best. A low bonnet line has been obtained by the now common device of incorporating the air intake scoop in the bonnet lid, to clear the highest parts of the engine installation. The radiator air intake is exceptionally wide and its depth is small; thus it calls to mind the type of air intake commonly seen on the leading edge of the wings of high-speed aircraft. Inside this intake, spot lamps are mounted on each side.

There is no bumper. Instead, there are four over-riders two on the front of the wings, below the headlamps, and two mounted under the radiator air intake, just inboard of the spot lamps. The over-riders on the front of the wings are equipped with large rubber buffers. It seems hardly likely that any of these over-riders would give much protection against a heavy blow, but possibly they are adequate since they are shaped in such a manner that the front end of the car would tend to ride over obstructions. They do not give any protection, of course, to the side panels.

A well-streamlined effect has been obtained by virtue of the style of the body sides. The front wing crown is of unbroken streamline form, since the headlamps are recessed in the wings and covered by moulded transparent plastics shaped to conform with the wing profile. A line is pressed the full length of the body side between the wheel arches and is continued at the front by the line of the lower edge of the lamp housing.

On each side at the rear, the popular fin type wing form has been adopted, the crown line being swept up sharply from the door shut pillar and then extending almost horizontally to the extreme rear end, where all the rear lamps are mounted. These lamps are enclosed by a moulded transparent plastics cover, shaped to form the rearmost tip of the top of the fin on each side; in other words, they are in the angle between the upper and trailing edges of the fin. This lamp arrangement harmonizes well with the shape of the bumper below.

A full-width chromium plated bumper is incorporated at the rear, and its ends are wrapped round the sides. This bumper is unusual in that its shape is almost a replica of that of the panels that it is intended to protect. It is, therefore, hardly likely to resist such severe blows as would a bumper of more conventional channel section. However, as can be seen from the accompanying illustration, its ends are wrapped under in such a way that they would tend to cause the vehicle to over-ride any obstacles on to which it might be backed accidentally. The bumper assembly is in three pieces, and is rubber-mounted on the panelling. Two chromium plated, twin exhaust tail pipes project from beneath the rear of the car. Since these exhaust pipes are liable to take the first shock of any rear-end collision, no matter how slight, it seems likely that this feature will prove to be a transient fashion. Currently, it is widely employed on the American as well as European cars.

The dash facia is an example of the best practice in sports car design. A matt-finish, black paint is applied to prevent reflections at night. The instrument dials are few in number and are large, as can be seen from the accompanying illustration. They are, from left to right, speedometer, engine speed indicator, and oil pressure, water temperature and fuel contents gauges. All the switches are in a readily accessible position on the propeller shaft tunnel, between the two seats, which are of the bucket type.

Two toggle clips on each side and the hook, for the drop-head, on the rear decking secure the hardtop of the Pinin Farina Alfa Romeo. This head can be removed or replaced easily in three minutes

Simplicity is the keynote of the instrument layout on the facia of the Pinin Farina Ferarri Spider 300 Gran Turismo. A special matt-finish black paint is applied to the facia to prevent reflections

A low bonnet line and a combination of good streamlining with modern styling are noteworthy features of the Pinin Farina Ferarri. The door handles have been well chosen for this style

On the Pinin Farina Ferarri Spider, the arrangement of the rear lamps and the ends of the bumper is well balanced

The windscreen has a slight wrap-round portion at each side. An unusual feature of the assembly is that there is no head rail. It would appear that adhesive is applied both between the glazing rubber and its glass and between the rubber and its housing. There seems to be little merit in this arrangement, except from the styling point of view. The absence of the head rail tends to make the car appear to be exceptionally low-built. An unusual feature of this design is that the top of the door on the driver's side is lower than that on the other side.

For some time, Pinin Farina has been producing sports two-seater drop-head coupés based on the Alfa Romeo Guilietta chassis. To make this car more comfortable in winter in colder climates, and also to protect the soft folding hood against the weather for part of the year, a hardtop has been designed. This top can be removed or fitted easily in three minutes, since it is secured by only four toggle clips. Two chromium plated hooks on the rear decking, which are primarily intended to anchor the soft head, also help to hold down the hardtop. There are two toggles on each side, one at the top of the windscreen pillar and the other immediately behind the seat squab.

The steeply sloping lines of the windscreen pillars are matched by the similar slopes of the door shut pillars on each side and the sides of the wrap-round rear window. Also in harmony with this sloping line is the sweep of the door shut line below the waist.

A three-piece wrap-round rear bumper conceals an outwardly-extended flanged joint between the boot floor and the skirt panel. This, of course, greatly facilitates production. The rear lamps are in the tops of the trailing edges of the fin type rear wings, the crowns of which are of rounded section. There is nothing unusual about the front end styling except, perhaps, that external, chromium plated hinges are used on the bonnet lid. A central chromium plated strip on the lid and scuttle also help to break up the plainness of the bonnet.

Ghia Suisse

Ghia make three different bodies for an Alfa Romeo chassis. One is a four-seater convertible, while the other two are saloon cars, one being a four-seater and the other a fixed head coupé with two additional occasional seats behind those of the driver and passenger. All the models have the same front end style, but the additional lamps on the horizontal bars in the radiator grilles of the models illustrated are optional.

The rear ends are similar, but not identical. In the four-seater, to obtain adequate headroom for the rear passengers the panoramic rear light is more nearly vertical and the rear canopy higher than in the coupé. The rear edge of the canopy projects over the rear light.

At the front, the windscreen, which is of the wrap-round type, is steeply raked. The screen pillars are unusually slender, their width, as viewed from the driver's seat, being only $\frac{3}{4}$ in between the glazing frames. The total width of the obstruction in the field of vision afforded by the windscreen pillar and door pillar together is only 2 in: this, of course, is as viewed from the driver's seat. The true width in side elevation, as opposed to the projected width as seen by the driver, is $2\frac{1}{2}$ in.

The styling of the radiator grille is typical of that adopted by Alfa Romeo for a number of years. It comprises a central shield, representing the traditional grille, with an air intake opening on each side. These openings are of horizontally elongated form, bounded by a chromium plated finisher strip, and there is a horizontal bar in each. Optional extra lamps, already mentioned, can be mounted in the centre of this bar, while the direction indicator lamps are at the outer ends. The glasses of the indicator lamps extend an inch or two round the sides of the vehicle, so that the signal can be seen from the side, as well as from the front.

As can be seen from the accompanying illustration, this is

The Pinin Farina coupé on the Guilietta chassis is now available with a hardtop, which can be fitted when the drop-head is folded

The dihedron device, used last year by Pinin Farina on his Florida model, is employed by Ghia Suisse on the sides of this body based on a Volkswagen chassis

one of the best arrangements incorporating the traditional Alfa Romeo front end treatment that have been developed so far. It is successful because of the harmony of line obtained by accentuation of horizontal features above the bumper. The vertical lines of the central radiator grille in many other designs tend to clash with the horizontal features, but this coachbuilder has managed to blend them into the overall design of his car. This he has done by mounting the grille on the front end of a projection pressed in the bonnet surround panel: the boundary lines on each side of this projection extend back over the bonnet lid. Midway between these lines is a chromium plated finisher strip. The projection is balanced on each side by the forward extensions of the wings to house the headlamps.

On each side of the body, the line between the door and the wrap-round portion of the windscreen is swept rearwards and upwards, as on most of the American cars incorporating this feature, and a similar shape is pressed in the rear portion of the door and the rear quarter panel to represent the leading edge of the fins of the rear wings. On the convertible model, however, this line is absent at the rear, and a dummy air intake device is incorporated in the rear quarter to take its place in breaking up the plainness of the panel. It would appear that a better effect could have been obtained had the line between the door and the wrap-round portion of the windscreen been used to continue the line of the front wing crown into the waist line. A feature that might be criticized is the downward slope of the chromium plated strip that passes from front to rear on each side; it makes an unfortunate contrast with the crown lines of the fins on the rear quarters.

The drip channel extends up the front pillar, along the cant rail and down the rear quarter pillar. It terminates just above the tail end of the chromium plated waist rail. The end of this rail is shaped in such a manner that water running on to it from the drip channel is spread out, so that it does not leave a dirty line on the panel. The shape of the end of the waist rail is also such as to blend into the line of the drip channel.

There is no pillar above the waist at the rear edge of the door, the door glass sliding up and down on a rubber seal on the door shut pillar. All the glazing at the front and rear is carried by rubber sections in which is a channel adjacent to the outer of the two flanges that hold the glass. In this channel is fitted a flexible wire filler, the wire being coiled and chromium plated, so that the filler has the appearance of a length of flexible gas piping. To remove the glass it is only necessary to withdraw this flexible filler wire from its channel, then the rubber flange that holds the glass can be deflected into the channel and the glass withdrawn.

Above: Interior of the Volkswagen by Ghia Suisse, showing how the lines on the door trim harmonize with those on the seats

Left: Rear end of the Ghia Suisse Nardi Fiat. This vehicle has a curved rear light, which, of course, is less expensive than the fully wrapped-round type

Comparison of this illustration with that at the foot of this page shows that many of the body components of these two Ghia Suisse models are identical

Below: Interior and facia arrangement of the convertible version of the Ghia Suisse body based on the Alfa Romeo chassis

In the boot, the battery is on one side, with the petrol filler behind it. The spare wheel and tools are on the other side. All these components are behind the wheel arches. The petrol filler tube is in a box-shaped housing, covered by a hinged flap, secured by a toggle clip. To avoid the danger that petrol may spill into the boot, the base of the box surrounding the filler cap is open so that, should any petrol overflow from the filler neck, it drains away directly to the ground underneath the car. The clearance between the filler neck and the box surrounding it is large, so there is no likelihood of rattles developing.

Ghia Suisse also produce a body on a Nardi chassis, based on Fiat components. There is nothing unconventional in the front end styling of this model. It has exceptionally slender windscreen pillars, of much the same layout as on the Ghia Suisse Alfa Romeo. However, the screen is not so deep as that on the Alfa Romeo and this restricts the range of vision of tall drivers.

The trim is in hide, and the facia is covered with a special figured hide. Whereas on the Alfa Romeo a conventional cloth head-lining is employed, the Nardi Fiat has a hide head-lining, pierced with holes, about $\frac{1}{16}$ in diameter and at slightly less than $\frac{1}{8}$ in pitch. This head-lining is backed by a noise-absorbent material—a similar arrangement was employed in last year's Packard Patrician. The employment of a noise-absorbent material is common practice in the design of special buildings and other applications, in which acoustics problems arise. It can, therefore, be assumed that the object of this arrangement is to prevent reverberation in the body.

This model has obviously been designed for sporting applications, for it has a well streamlined rear end. A steeply-raked rear light is incorporated and the downward slope of the panelling below it curtails the space in the boot. As can be seen from the illustration, the arrangement of the rear quarters of the canopy is unusual. A full-width rear light is employed, but it is not wrapped round the quarters. Instead, its sides are parallel to the cant rail. This is an advantage, because glass for the wrap-round type of rear light is much more expensive than for this simpler type. In addition, the arrangement presents fewer problems with regard to styling.

There is a large petrol tank under the boot floor, and the filler neck, as on the Alfa Romeo, is inside the boot. Extremely thin fins are incorporated on the rear wings and a chromium plated finisher strip is fitted over their upper and trailing edges. Presumably this strip conceals a panel joint. A two-piece rear bumper is employed, but it is wrapped round the rear quarters. This arrangement has some merit

The front end arrangement of the Ghia Suisse Alfa Romeo is an example of the successful incorporation of the traditional radiator grille in a modern design

Left: The Bentley radiator grille on this model by Graber gives a high bonnet line by comparison with those of the other coachbuilt bodies illustrated

Right: The four-door Fiat 600 body by Francis Lombardi has no centre pillar, the doors being hinged at the front and rear

because the two components, if properly mounted, protect both the rear quarters and the rear end of the vehicle. At the same time, since the bumper is made in two pieces, instead of three, less material is required for its manufacture, and assembly costs are lower.

Ghia have designed for the Volkswagen chassis a fixed-head coupé which is, perhaps, one of the best styled bodies that have been produced for this vehicle. Unlike many of the cars designed by Continental coachbuilders, this one has adequate headroom over the front seats, although there is not much clearance over the occasional rear seats. To obtain this headroom at the front it has been necessary of course, to place the canopy relatively high above the waist line of this low-built vehicle. Therefore, to avoid a top-heavy appearance, the dihedron device, previously used by Pinin Farina on the Florida model introduced last year, has been adopted on the body sides.

As can be seen from the accompanying illustration, the line formed by the dihedral angle extends between the wheel arches. Although it is in line with the bumpers at the front and rear, the break formed by the wheel arches represents a marked discontinuity, and a better result would probably have been obtained had the apex of the dihedral angle been in line with at least one of the top edges of the wing cutting lines and a lamp.

On this car, a chromium plated strip is incorporated at the level of the top of the sill. This is at first sight surprising, since the dihedron device has generally been found to be sufficient by itself to break up the plainness of the body side and to accentuate the horizontal lines of the vehicle. However, in this particular instance, it is certainly necessary to give additional emphasis to the horizontal features between the wheel arches, because of the relatively short wheelbase of the chassis.

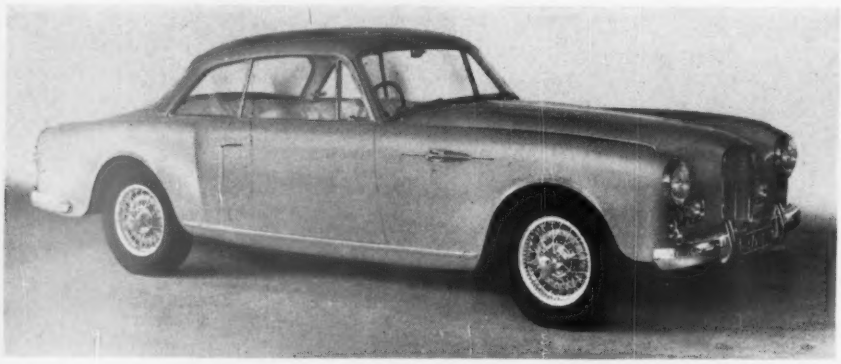
Both the front and rear bumpers are of light construction. In fact, they are more in the nature of decorative bars; the front one bisects horizontally the radiator air intake and therefore is higher than the bumpers of almost all other cars. The direction indicator lamps are in housings formed in the horizontal bar. A chromium plated capping is fitted round the edge of the radiator air intake opening; it surrounds a pierced corrugated aluminium backing-grille, of the type previously described.

At the rear, twin exhaust pipes project prominently. The engine installation is exceptionally accessible in a large compartment. Luggage is stowed behind the rear seat, since the compartment under the bonnet is entirely filled by the petrol tank and spare wheel. The average distance between the back of the rear seat squab and the engine bulkhead is about 12 in.

A noteworthy feature of the design is the styling of the trim. From the illustration showing the interior, it can be seen how well the lines of the piping on the door harmonize with those on the seats. The facia is of simple layout, and its horizontal features are accentuated by virtue of the fact that, in section, it is similar to the leading edge of an aircraft wing: in other words, its depth is restricted. A chromium plated strip extends along the waist rails on each side and is continued horizontally along the rounded edge of the facia. The instruments are grouped on a small panel above the steering column. This panel has a chromium plated hood to prevent the light of the instruments being reflected in the screen at night. Presumably the manufacturers are satisfied that there is no reflection off the bright chromium plating.

Graber

The latest of the Alvis models by Graber bears a strong resemblance to those that it succeeds, but the lines in general have been modernized. The front end is much the same as before, but a new feature is a line pressed along the crowns of the front wings. This line extends from about 3½ in behind the headlamps and joins the waist line at the base



Graber have modernized their body on the Alvis chassis. The line pressed in the rear quarter, to represent a wing, is an improvement on the chromium plated strip employed on the similar earlier model

of the screen pillar. A similar line is pressed in the rear wing crown, extending forwards from the same distance in front of the rear lamps and sweeping down parallel to the door shut line in front of the rear wheels. This downward-swept line is better than the vertical chromium plated strip used at this point on earlier models, because it does not make such a pronounced break in the horizontally-flowing lines of the body side. The scuttle side-panel of this car is unusually long and its plainness is broken by an imitation vent fitted with chromium plated finisher strips.

A new form of catch is employed for the bonnet lid. Under the dash facia there is a push-pull control that actuates a rotary hook, which engages a heavy-gauge wire bent to form an eye. The use of wire for the eye is a good feature, since it gives the resilience necessary to hold the lid securely enough to prevent it from rattling. It also allows a certain amount of tolerance with regard to location. To centre the hook relative to the eye, a peg mounted on the leading edge of the lid engages in a socket on the bonnet surround.

Above the waist there is no pillar on the rear of the door. The drop glass closes against unusually thin rubber seals on the door shut pillars—a feature that indicates that skilled workmanship is employed in the manufacture of these bodies. A pillar, with pivots at its upper and lower ends, supports the front edge of the rear quarter light. A toggle type catch is fitted at the trailing edge of the glass. Thus, there are no glazing rails on any of the side light glasses. The triangular glass ventilating panel above the front of the door also has no glazing rail. It is opened and closed by means of a winder type handle, which actuates the lower pivot. This glass, like all the others, bears against a thin flexible seal when it is closed.

Graber also make a body on a Bentley chassis. This model has a prominent ridge, or crease, pressed along the crown of the front wing, as on the Alvis. However, in this application, the line is extended back below the waist to within 3-3½ in from the line that is pressed in the rear quarter to form the rear wing outline. Evidently the extension of this wing crown line across the door is desirable because of the greater depth of the side panels on the Bentley.

On the rear wing, the ridge on the crown line is much higher, its rear end being about 2½ in above the surrounding panel, as compared with the height of about ¼ in of the ridge on the front wing. In other respects, the general form of the rear quarter panel, with its rear wing impression, is not unlike that of the Alvis. A conventional tonneau cover is fitted; the pressed steel covers employed on some of the American cars are not very practical, since they are easily scratched and damaged in other ways, and are awkward to stow when not in use.

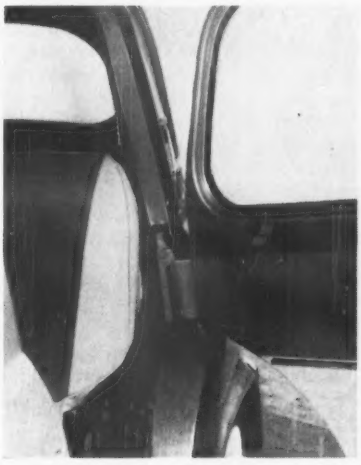
The traditional radiator grille that is the hallmark of the Bentley chassis is employed. A chromium plated strip on the longitudinal centre line of the bonnet lid conceals the hinge about which the divided lid pivots. The high bonnet line of this design is in marked contrast with the lines of the other modern designs of Continental coachbuilders.

A noteworthy feature is the employment of a wrap-round windscreen without the awkward elbow-shaped frame on each side, which is commonly employed by other manufacturers. As on the Alvis, there are no glazing frames round the side light glasses. The upper pivot of the glass ventilating panel at the front of the door is practically in line with the leading edge of the glass so, when the panel is open, this edge remains in line with the windscreen pillar and does not, therefore, obstruct the range of vision. A chromium plated drip channel is fitted to the exterior of the lower edge of this ventilating panel. It extends from the front edge of the glass to a point just behind the pivot; thus, it prevents water from draining down the glass and into the interior of the car when the panel is open.

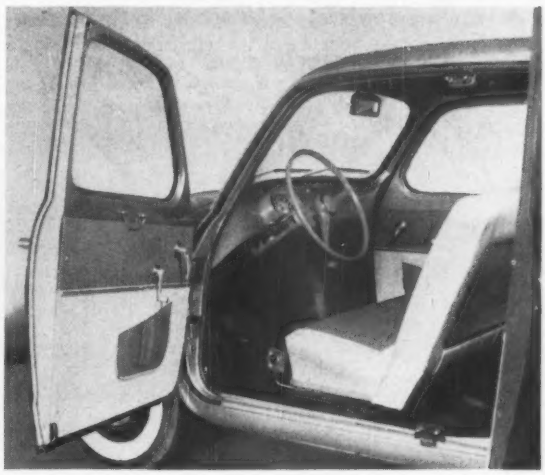
Francis Lombardi

Francis Lombardi has adopted an unusual solution to the problem of providing adequate access to the rear seats of a very small car. This manufacturer has fitted a four-door body on the Fiat 600, which, of course, in its standard form has only two doors. The front doors are hinged at their leading edges and the rear doors are hinged at their trailing edges. There is no centre pillar. The doors on each side shut against two stop plates, one on the cant rail and the

Although only one hinge is employed to carry the rear door of the Francis Lombardi Fiat it is large and of heavy construction



Two hinges carry the front door of the Francis Lombardi model, and stop plates are fitted to the cant rail and to the sill



The Vignale car, styled by Michelotti to resemble a launch, is a good example of a design for a special purpose: it is intended for carrying people between hotels and the beach. The panels at the front, the upper half of the body sides, and the lid of the engine compartment at the rear are painted and figured to represent planking, while the lower half of the body sides, the rear decking and the canopy are bright blue

other on the sill. Each stop plate carries two locating striker pegs, one for each door.

As can be seen from the accompanying illustrations, two hinges carry the front door, while the rear door is hung on one hinge. This single hinge at the back is exceptionally large and, since the door is small and light, it would appear to be adequate. Both doors have drop glasses, as also has the latest version of the standard Fiat 600 model. However, in the four-door car by Francis Lombardi, because the rear door is shaped to clear the rocker panel, its glass only drops a few inches.

It is perhaps easier to make a pillarless conversion of the Fiat 600 than of most other cars; this is because of the strength afforded by the box section, longitudinal member which, in this vehicle, takes the place of the propeller shaft tunnel. Additional strength is also provided by the incorporation of a box section cant rail, reinforced windscreen and door pillars and a double-skinned rear quarter panel. The rocker panel also is double-skinned to form a box section of complex shape. The two welded joints of the cant rail section are at the door shut flange and the drip channel. Between the roof panel and the bracket that carries the upper pair of location pegs, there is an 18 s.w.g. pressed gusset-plate. The front end of the cant rail is welded to the top of the windscreen pillar, while its rear end is welded to the box section that reinforces the rear quarter. A top hat section gusset is welded by its flanges to the top of the sill, between the bracket that carries the bottom pair of locating pegs for the doors and the rocker panel.

An interesting feature of the front seats, which can be seen in the illustration of the interior of the vehicle, is that the rear faces of their squabs are recessed about 2½ in to give extra knee-room for the rear passengers. This makes possible the employment of a bench type front seat. Although there does not seem to be much point in using a bench type seat in such a narrow car, this device might be of practical value in a vehicle that is wide enough for the accommodation of three people in comfort at the front. Normally, of course, in such a small car, bucket type seats are employed, so that the rear seat passengers can put their knees one each side of the seat squab in front of them.

To enable the recess to be incorporated in the rear face of the front seat squab, wire-in-torsion type springs are employed. These springs are carried on tubular frames round the edges of the squab. This type of springing, of course, is very thin and takes up but little of the length available for the passengers in the interior of the car. Another advantage of this arrangement is that the seat is much lighter than most other types.

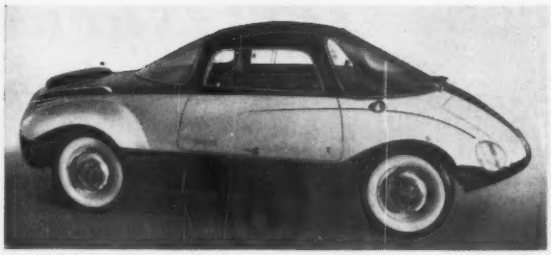
Vignale

Two interesting models have been introduced recently by Vignale. One is a tiny high-speed car based on the Fiat Abarth 750 chassis and the other is a special-purpose multi-seat vehicle based on the Fiat Mulitpla chassis. Both bodies are noteworthy for their extremely unconventional features.

The Fiat Abarth 750, which is only about 45 in high, is fully streamlined. That is, it has a steeply sloping windscreen, which is shaped to conform with the lines of the nose of the car. Similarly, the rear light is fully streamlined. No attempt has been made to reproduce a conventional bonnet at the front. Instead the forward end of the car is shaped something like the nose of an aircraft fuselage.

Evidently, considerable pains have been taken to obtain a good weight distribution. The petrol tank is at the front, and its filler is just below the waist, to the rear of the front wheel. Also to give a good weight distribution, the driver's and passenger's seats are well forward. These seats are of

Adequate provision for ventilation of the engine compartment at the rear is a noteworthy feature of this vehicle, designed primarily for use in the summer season in a warm country where, in many holiday resorts, mountains are close to the sea



Above: There is no bonnet on the Vignale Fiat Abarth 750 and the occupants are seated well forward, to improve weight distribution

Right: At the rear of the Vignale beach-car on a Fiat 600 Mulitpla chassis, only the edges of the wicker seats are trimmed with hide

extremely light construction. They are fabricated with a single tube round the edges to form a frame, and the cushion and squab trim is based on wide straps stretched between these edge members. Gull-wing type doors are employed They have horizontally sliding glasses.

At the rear, large louvres, two on each side, are provided, one to ventilate the engine compartment and the other to allow free flow of air past the rear brakes. These louvres are unusual in that they are positioned longitudinally and are open to the sides, instead of being incorporated transversely and open to the front or rear. A large, rearward facing air intake is incorporated in the centre of the engine compartment lid.

Apparently, the body based on the Fiat 600 chassis is designed primarily for the use of hotels, for taking guests down to the beach and on short sight-seeing trips. It is a good example of a vehicle designed specially for a particular application. The styling is, appropriately, based on that of a boat; imitation timber planking is painted on the front and side panels, and on rear decking over the engine compartment.

A large transparent panel is incorporated in the canopy. The front edge of this canopy is supported on the head rail of the windscreen, and its only other support is two struts, one on each side, towards the rear end. A transparent plastics strip is mounted, rather like a drip channel, on each side of the canopy and it extends down the screen pillars to the low waist of the body. Presumably it is intended to act as a draught-deflector. Although the body sides are low enough for passengers to step over them, two doors are incorporated. There is a large air intake on the lid of the engine compartment, and there are also apertures in each side of the rear quarter panels. This attention to ventilation of the engine compartment is a good feature for a vehicle intended to be used in the summer season in a hot mountainous country.

A bench type seat, trimmed with hide, is employed at the front, and the spare wheel is mounted in a shallow recess in the rear face of its squab. The dash facia is much the same as that of the standard version of the Fiat Multipla. A curious feature of this vehicle, in view of its entirely open design, is that it is equipped with demisters for the windscreen.

At the rear, where the body is exceptionally wide, the ends of the bench type seat extend round the sides; it holds about six people. Since there is room for three on the front seat, there is a total seating capacity for at least nine; between the rear and the front seats, there is a relatively large area of floor on which tiny children would doubtless also be seated during short journeys to the beach. An unusual feature of the back seat is that it is made of wickerwork and only its edges are trimmed with hide. This is a sound practical feature for a vehicle in which people wearing wet

On the Vignale beach-car, which seats about nine persons, the spare wheel is stowed on the back of the squab of the bench type front seat

swimsuits might be seated. There is a large chromium plated grab handle on each side of the rear face of the squab of the front seat, that is, adjacent to the doors.

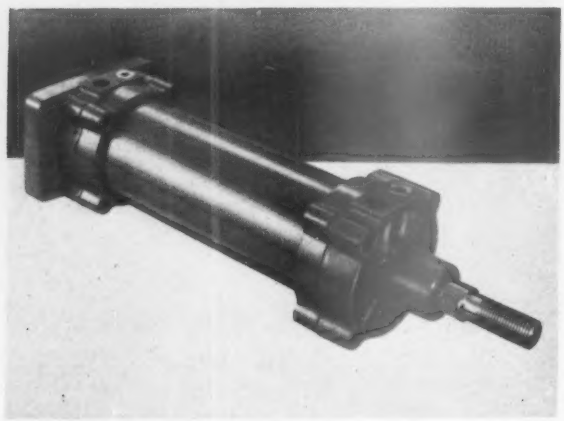
Continental coachbuilders, in general, are often criticized because of their unpractical outlook. Nevertheless, it should be appreciated that their cars are made in very small quantities for customers who want something distinctive and in a class different from that of the quantity-produced cars. To meet this demand, most of the Continental coachbuilders regard perfection of styling as the prime requirement. Evidently this feature is, in fact, a decisive factor so far as their sales are concerned. On the other hand, for cars that are produced in very large quantities, a compromise obviously has to be found, between the conflicting requirements of style, comfort and other practical features, to suit a vastly wider range of customers. Despite this, most of the large manufacturers study the coachbuilt vehicles with interest, because, in many respects, they illustrate sound fundamental principles of artistic design, even though these principles cannot be exactly translated into a practical design for mass-produced cars.

The styling of motor cars is, of course, a matter for specialists, for not only does it require a good artistic sense and creative talent, but also a thorough appreciation of practical limitations peculiar to motor car design. In general, while the engineer must inevitably give guidance as to what is practicable and the sales executive decide which of several designs will have the widest appeal, only the artist can create these designs: few engineering or sales executives are qualified to advise the stylist on purely artistic aspects.

SUPER-CUSHIONED POWER CYLINDERS

Equipment for Decelerating Heavy and Fast-moving Masses Available for the Range of Baldwin Pneumatic or Hydraulic Cylinders

FLUID-POWER cylinders are commonly furnished with cushioning arrangements to decelerate the piston and its associated load at the end of its stroke, in either or both directions, in order to obviate mechanical shock. These arrangements may be of various types; resilient pads, springs, oil-check units, air-check units or special porting arrangements in the end covers. In Baldwin equipment the cushioning effect is produced by closing the exhaust port at a predetermined point before the piston reaches the end of its stroke, thereby trapping a certain volume of the motive fluid. This trapped fluid is allowed to escape relatively slowly by way of an orifice which is adjustable to control the rate of deceleration to suit the specific loading.



Pedestal-mounted power cylinder with standard cushioning device

The range of Baldwin cylinders includes types furnished with single or double piston rods, in six bore sizes from 1·5 in diameter to 8·0 in diameter. In all cases the length of stroke is arranged to suit specified requirements. They are designed for air up to 150 lb/in² pressure and for oil up to 250 lb/in² pressure. Cylinders can be supplied without cushions, with a cushion at one end only, or with cushions at both ends, and with one of seven different mountings. The standard cushioning device is arranged internally and functions as shown in the accompanying series of three diagrams.

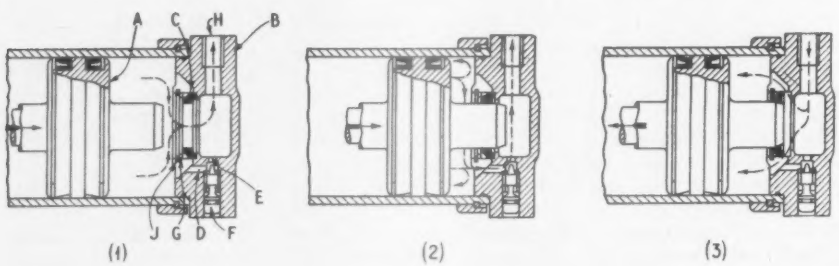
In the first, the piston A is moving towards end cover B under the influence of the power fluid, that is, air at full mains pressure, on the left-hand side of the piston. On the right of the piston, air is being expelled through the bore of the cushion seal C and port H in the cylinder cover at full bore flow. In this condition there is no restriction to the exhaust flow of the air.

Conditions change when the boss on the piston has entered the special, fully-floating cushion seal C, as shown in the second diagram. Free exhaust is now terminated and air trapped in the end of the cylinder can escape only through the drilling D and orifice E to port H. The effective cross-sectional area of orifice E can be varied by adjustment of the screwed needle F to meet requirements.

It will be seen that a predetermined volume of air is trapped between the piston and the cylinder cover. With continued movement of the piston towards the cover, this volume of air is compressed and an increasing rise in pressure is generated in opposition to that causing movement of the piston and to the inertia of the load. The moving parts will thus be decelerated until further movement is prevented by physical contact between the piston and the end cover or by some external stop. The rate of escape of the trapped air, and, therefore, the cushioning effect provided, is controllable by adjusting the area of orifice E by the screw F.

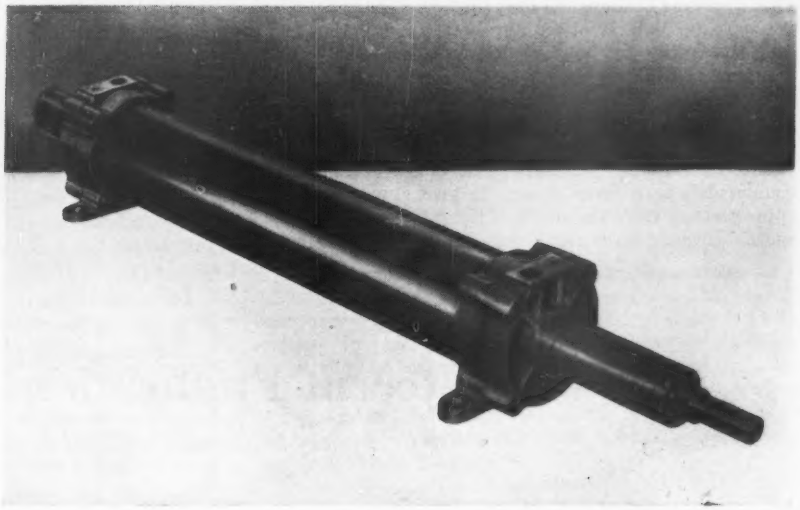
In order that the return stroke of the piston may be made under full power, immediately pressure air is applied to the exhausted end of the cylinder, the cushion seal C is arranged to function as a non-return valve. When the pressure air is admitted to the end cover the flow through orifice E will, of course, be reversed, but the pressure lifts the cushion seal C from its seat, providing an annular passage through which the air can freely enter the cylinder as indicated in the third diagram. Full power is available immediately the piston moves on the return stroke. Complete ejection of the cushion seal is prevented by circlip J. When the boss of the piston is withdrawn from the cushion seal, spring G returns the seal to its seat. The annular passage is closed and the flow of air is continued without interruption through the bore of the seal. The features described above form the subject of British Patent No. 749770.

Applications occur in practice where a relatively large mass moving at high velocity must be decelerated and stopped without mechanical impact. In such instances the standard cushioning arrangements are not adequate and it becomes necessary to increase the volume of air trapped between the piston and the end cover when the piston boss enters the cushion seal. This is effected by increasing the length of the piston boss so that its end enters the seal at a point before the end of the stroke earlier than in the case of the standard arrangement, and providing an extended cap or seal



A *piston;* **B** *end cover* **C** *cushion seal;* **D** *escape drilling;* **E** *escape orifice;* **F** *orifice adjusting needle;* **G** *seal return spring;* **H** *air port;* **J** *seal retaining circlip*

Diagrams showing operation of cushioning arrangements: 1 normal exhaust; 2 restricted exhaust whilst cushioning; 3 movement of cushion seal on return stroke



Super-cushioned power cylinder equipped for foot mounting

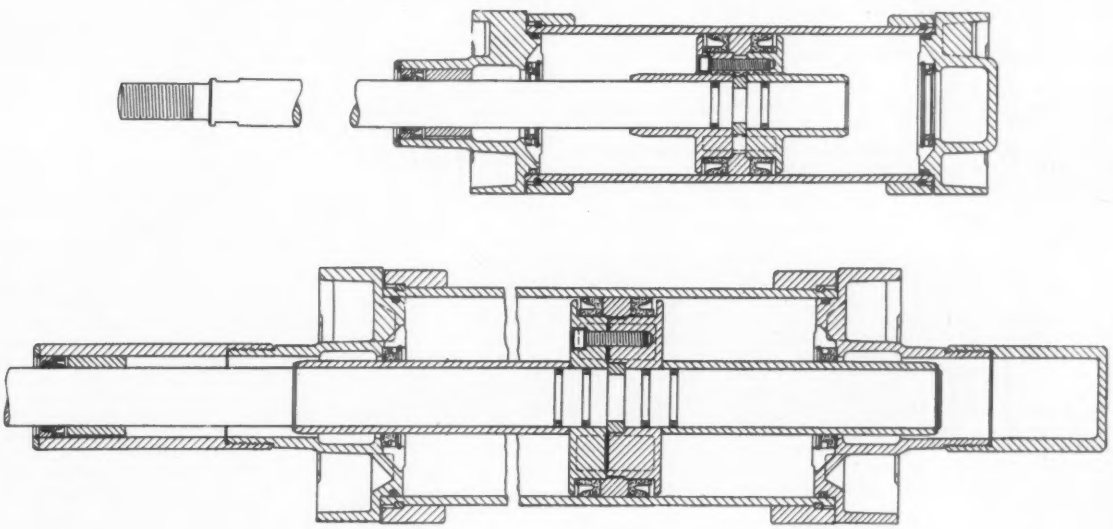
on the end cover to accommodate the extra length of the boss. Modification of the design of the piston and the end covers is necessary but the sealing and porting arrangements are unchanged in either design or operation. The piston bosses are no longer integral with the piston halves, but are separate sleeves retained on the piston rod by circlips, and the end covers are provided with screwed extensions. These modifications are shown for comparison in the sectional drawings of the two types of cylinders.

A common feature of all types is the method of unit construction which enables a cylinder to be built up and equipped in a wide variety of patterns to meet individual requirements. Super-cushioning can be applied to one or both ends of a cylinder or a "mixed" cushioning can be used. Cylinder barrels are of seamless mild steel tube, honed, hard chromium plated and polished in the bore, and piston rods are of mild steel, ground, hard chrome plated, and polished. Wiper rings are fitted as standard to prevent the entry of foreign matters to the bearings. End cover assemblies of malleable cast iron are rustproofed by a zinc diffusion process. They are secured to the barrel by socket screws engaged in a clamp ring or a mounting fitment located on a snap ring. There are no tie rods. By loosening the socket screws the end covers, or the mounting fitments, can be rotated through 360 degrees for alternative positioning.

The piston, of rustproofed malleable cast iron, is of a divided construction, the halves being registered on and clamped over a substantial split ring seated in the piston rod. Sealing rings and cup washers are all of oil and water-resistant synthetic rubber. All cylinders can be fitted with through-type piston rods supported in oil-retaining sintered bronze bushes in the end covers. These rods can support moderate side loadings or can provide accurate guidance to machine elements.

Mounting attachments can be fitted to meet all requirements. In addition to the basic cylinder assembly that can be clamped in position, fitments are available to provide feet at each end, a front-end pedestal, a rear-end pedestal, or trunnions at the front end, the rear end, or at the cylinder mid-point. They can be arranged singly or in combination and at any angular relationship. The centrally mounted trunnions should be used for all long-stroke cylinders that are disposed horizontally and need freedom to articulate.

Sectional arrangements of 3 in diameter cushioned cylinder and 4¼ in diameter super-cushioned cylinder



This mounting obviates the heavy bending moments which would be imposed on a fully extended piston rod if either a front-end or rear-end trunnion mounting was used.

An example of the use of super-cushioned power cylinders is provided on the extractors used in press lines in the Briggs Motor Bodies Ltd., plant at Dagenham.* These devices are mounted on a substantially built framed structure and fitted with an increasing gear, either a chain-driven countershaft or a lever device, to give a working stroke approximately twice the stroke of the power cylinder. In a specific instance the extractor jaws have to advance 50 inches in approximately one second, grip the panel, withdraw it from the press in about the same period of time, and deposit it on a conveyor. With a normally cushioned cylinder the entire structure was moved bodily under the force of the impact at the end of each forward and each reverse stroke. Super-cushioning equipment was fitted and the extractor is now operating without shock and with much less noise. The possibility of breakdown occurring due to fracture resulting from fatigue has been minimized.

The manufacturers of these cylinders are the Baldwin Instrument Co. Ltd., Brooklands Works, Dartford, Kent, a member of the Harper Aircraft group of companies.

*"*Automobile Engineer*," February, 1957.

Recent Publications

Brief Reviews of Current Technical Books

Automotive Brakes and Power Transmission Systems

By I. Frazee and E. L. Bedell.
London: The Technical Press Ltd., 1 Justice Walk, Lawrence Street, S.W.3. 1956. $8\frac{1}{4} \times 5\frac{1}{2}$. 266 pp. Price 58s.

This work deals with brakes and power transmission systems of passenger cars and trucks. It covers all the components between the flywheel and the point at which the power is applied, that is, the wheels. In other words, it includes brakes, clutches, fluid couplings, torque converters, transmissions, overdrives, power take-offs, transfer boxes, universal joints, drive shafts, differentials and axles. These subjects are dealt with in relation to design, construction, operation, maintenance and repair. However, emphasis is on the last three aspects.

In Chapter 1, all types of brakes, including manual, air, vacuum and electric, are dealt with. The next chapter is on power train assembly parts and contains a fundamental treatment of shafts, gears, chains, sprockets, bearings and seals. In the third chapter, clutches, fluid couplings and torque converters are discussed, largely from the servicing angle. The next two sections are on transmissions, including selective sliding types and planetary gearboxes, and auxiliary transmissions. This latter section covers overdrives, power take-offs and transfer boxes. Universal joints and propeller shafts are the subject of the sixth chapter, which is subdivided into sections entitled Constant velocity universal joints, Variable velocity universal joints, Drive shafts, and Pillow blocks and support bearings. Finally, there is a chapter on all types of driving axles. In general, the aim has been at producing a book that is adequate to give the master mechanic a knowledge of the basic automotive facts that will enable him readily to diagnose causes of breakdown, so that he can carry out his repair and servicing work intelligently, rather than by blindly following a service manual.

Valve Timing for Maximum Output

By E. Iskenderian.
Culver City: Ed. Iskenderian Racing Cams, 6,338 W. Sauson Avenue, California, U.S.A. 1956. $8\frac{1}{2} \times 5\frac{1}{2}$. 66 pp. Price $1.

The firm that have produced this book have specialized for many years in camshaft design for engines tuned for racing. It is to be expected, therefore, that they should know a great deal about the subject. In fact, the book will be of interest to the enthusiast who likes to tinker with his car to improve its performance.

The first 46 pages of the book deal with general principles and in the remainder the products of the company are outlined. These products include spring and camshaft assemblies for most of the American cars, as well as for the Austin-Healey, Jaguar, Volkswagen and Porsche vehicles.

The sections are headed as follows: Valve timing for maximum output; The camshaft; Types of cam followers; Racing valve springs; Cylinder head design; Better volumetric efficiency; How to determine port sizes; The poppet valve; Torque, horsepower and dynamometer testing; Top-tuners' tips; You must know your spark lead; Checking a cam in the engine; Juggling tappet clearance; Iskenderian engineered spring assembly; Ratio computer and displacement guide; Hard face overlay grinds; and Popular regrinds.

Motor Vehicle Technology

By R. W. Bent, M.I.Mech.E., A.M.I.M.I.
London: Sir Isaac Pitman and Sons Ltd., Parker Street, Kingsway, W.C.2. 1957. $7\frac{1}{2} \times 5$. 109 pp. Price 8s. 6d.

This is the first part of a work that has been written specially for students preparing for the examinations of the City and Guilds of London Institute (Motor Vehicle Service Mechanics), the Union of Lancashire and Cheshire Institutes, the Union of Educational Institutions, and the Institute of the Motor Industry. The majority of the illustrations are line drawings, which are designed to show principles rather than related to any particular make of car. Students should find these helpful, since sketches of this type are an important part of the work for the examinations of the authorities already mentioned. At the end of most chapters, a maintenance section is included. The principal additions in this, the third edition of the work, are sections on the two-stroke cycle and on battery maintenance.

Vauxhall Cars

By F. A. Stepney Acres, M.I.Mech.E.
London: C. Arthur Pearson Ltd., Tower House, Southampton Street, W.C.2. 1957. $7\frac{1}{2} \times 5$. 241 pp. Price 10s. 6d.

This book, which is one of the Motor Car Maintenance and Repair Series, deals with all Vauxhall cars from 1933. It is intended to be of use both to the owner-driver and to garage mechanics. Chapter 1 occupies only six pages and is on the identification of models. It is followed by a chapter giving information on top overhaul. In view of the number of variations made throughout the years, it has not been possible to deal with each model comprehensively enough to include notes on major overhaul.

The remaining chapters are entitled: The engine cooling system; Fuel and exhaust systems; Gearboxes; Clutches; Brakes, rear axle and rear suspension; Front axle and front suspension; and Ignition and electrical equipment. In this last chapter, wiring diagrams for all Vauxhall models produced since 1933 have been included.

Decarbonizing Made Easy

By E. Molloy.
London: C. Arthur Pearson Ltd., Tower House, Southampton Street, W.C.2. 1957. $7\frac{1}{2} \times 5$. 208 pp. Price 10s. 6d.

This is another of the many books for automobile service mechanics and for enthusiastic owners who wish to undertake the work of decarbonizing and valve grinding. The first section is mainly for readers who have not had a regular training in automobile repair work. It includes general notes on decarbonizing and valve grinding, details of the processes and problems involved, and notes on non-adjustable tappets, side valve and overhead valve engines, and hydraulic tappets. Finally, on pages 30-32, there is a series of questions and answers on decarbonizing and valve grinding. The second section of this book, which occupies 169 pages, gives notes on specific models. Section three comprises four pages of reference data, including torque-wrench loadings for cylinder head nuts, a sparking plug comparison chart, and a table of metric equivalents of thousandths of an inch.

TOWN GAS AS TEST-BED FUEL

G.M. Gas Carburation System. Specialized Equipment for Production Testing and Running-in.

Economical Operation at About Half Petrol Cost

INITIAL running-in of either new or reconditioned engines on town gas is a recognized procedure that has been followed in some works for many years. It is an obvious method of cost reduction since the use of a taxed fuel is eliminated. Apart from low cost, however, the use of fuel drawn from the gas mains offers a certain degree of convenience together with a reduction of fire risk in so far that in the event of trouble an instant and complete shut-down can be effected of either an individual unit or of an entire section or shop. The storage of quantities of petrol adjacent to the engines is also obviated.

Early gas fuel installations were generally crude, often being in the shop-made category and commonly no more elaborate than a small-bore gas pipe with a regulating tap inserted in the existing air intake. Of course any petrol engine will run on town gas admitted in this rough and ready way although the method of control is too insensitive to cope with large and rapid changes of speed or load. Gas fuel in such applications was therefore confined to running-in where relatively constant conditions obtained.

Present-day standards of component finish, fitting tolerances and engine assembly have completely altered the attitude towards running-in, which is now regarded almost as a relic of the early phase when engines were built up with tight bearings. Internal friction then provided an initial load against which the engine would run until such time as a predetermined rise of speed was observed, indicating that the working parts had bedded in sufficiently to allow the unit to be put into use with reasonable safety. A final period of running-in might be allowed, however, with the gas supply slightly reduced so keeping the speed constant.

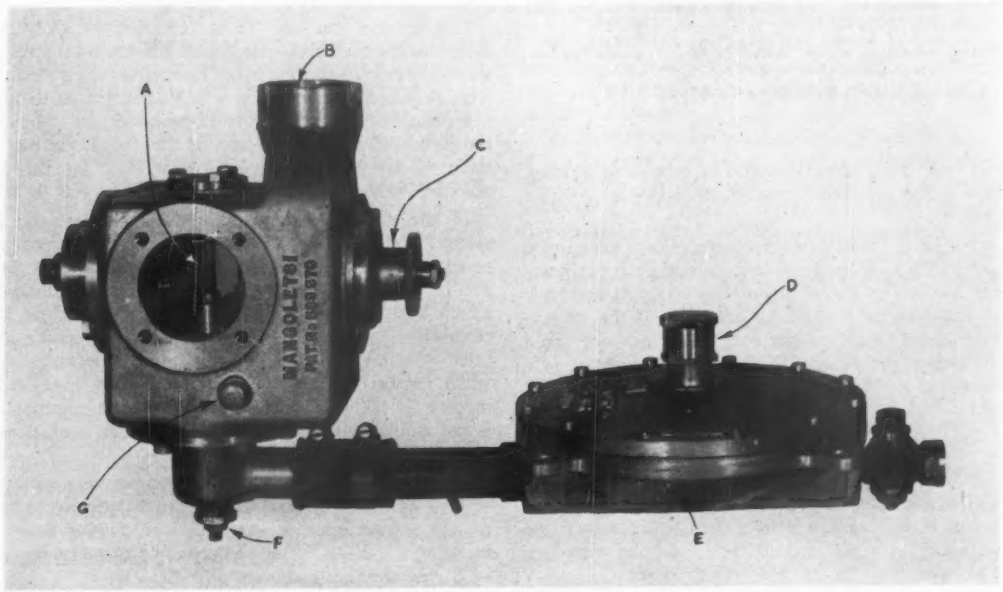
The provision of a town gas supply system on a running-in stand was thus no more elaborate than that involved in coupling up a simple domestic appliance, subject of course, to the statutory requirement that there shall be interposed between the main and the operative equipment a sensitive device capable of isolating the public supply both from engine-induced depression below atmospheric level and from blow-back similarly originated.

A somewhat different case is presented when it is desired to use town gas for full scale production bench testing. For such a purpose the gas fuel control must be responsive to such load and speed change requirements as are normally encountered in the course of testing for overall performance. In this respect, of course, the "pipe and tap" arrangement is impracticable since it cannot be kept in step with rapid variation in either quantitive or qualitative requirements. In short, before an engine can be effectively bench tested on town gas fuel a suitable carburetter must be provided which is at least as responsive as the normal petrol carburetter appropriate to the particular engine in question.

The gas isolating device which, as already mentioned, is a statutory requirement in such installations, must also serve a more complex duty than that of a simple cut-off valve, for it is important that the carburetter shall be supplied at a constant pressure preferably slightly above atmospheric. The device, therefore, must serve as a governor which will react so sensitively to the inevitable variations in mains

Large G.M. gas carburetter coupled to single-stage governor

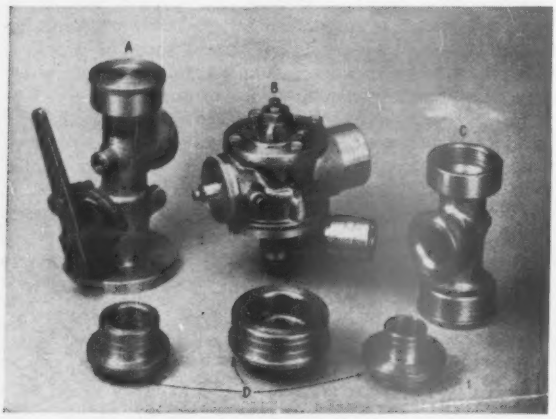
A *fixed guide rod for drop valve*; **B** *air intake*; **C** *idling air*; **D** *governor adjustment*; **E** *governor*; **F** *gas adjustment*; **G** *main air adjustment*



pressure that its output will be steadily maintained at about $\frac{1}{4}$ in. water gauge pressure irrespective of load variations.

With petrol systems the pump feeding the carburetter may operate at a delivery pressure of from 2 to 4 lb/in² although this does not influence the fuel in the jet which is under normal atmospheric pressure due to the venting of the float chamber. Depression in the intake manifold has only to lift the petrol in the jet about $\frac{1}{16}$ in to induce the required flow and the fuel is not subject to change of volume or density in the process.

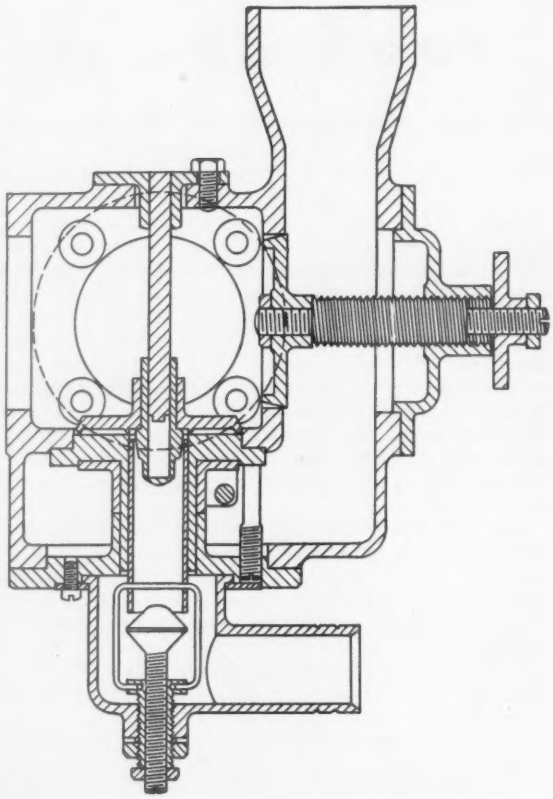
Gaseous fuel, on the other hand, may be supplied to the gas carburetter under positive pressure or it may be delivered at the governor outlet at atmospheric or even sub-atmospheric pressure. In the latter condition manifold depression is also necessary to induce full flow and the first and obvious effect of this is to attenuate the gas, since the depression will be communicated throughout the passages leading back to the governor. If, on the other hand, gas is supplied to the carburetter at positive pressure, attenuation does not occur. In other words, where the gas is reduced to zero or negative pressure at the governor, its density at the carburetter will vary to a considerable extent according to running conditions, so producing marked qualitative mixture variations. When the gas enters the carburetter at positive pressure mixture, conditions remain substantially stable but some form of cut-off valve becomes necessary to stop the flow when the engine is at rest. This valve must also be capable of limiting the gas flow to the required minimum necessary for a stable idling mixture.



A *T adapter with friction-damped throttle;* **B** *small carburetter;* **C** *plain T adapter;* **D** *hose connection inserts*

G.M. gas carburetter and adapters

Many attempts to provide gas carburetters have been made but in most instances it has been obvious that their designers have been obsessed by petrol carburetter concepts and have made the fundamental mistake of adhering to the venturi type of instrument in accordance with petrol practice. In a petrol carburetter the placing of the jet in the throat of a venturi results in a greater extractor effect on the liquid fuel than would obtain if the jet were in a plain bore pipe. This, of course, is the recognized method of compensating for the inertia lag of the liquid fuel. A similar arrangement in a gas carburetter produces to an even greater extent the capacity to maintain strength. Thus, under conditions in which the proportion of fuel is sustained in a petrol carburetter, the equivalent result in a gas carburetter of venturi type is a tendency to over-enrichment with rising speed.



Large M-type G.M. gas carburetter with downdraught air intake

Some justification for the venturi type of gas carburetter may be found when it is associated with a governor that reduces the supply to atmospheric or sub-atmospheric level. Such a governor gives an automatic cessation of gas flow when the engine stops. Because of that characteristic, however, an appreciable manifold depression is needed to restart and maintain gas flow. The problem of attenuation is considerable with such an arrangement.

During the war the G.M. Carburetter Co., now of Knutsford, Cheshire, carried out a great deal of development work in association with many municipal bus operators who were required by the Ministry of Fuel & Power to operate a percentage of their bus fleets on producer gas. More than a thousand delivery vans were also fitted with gas bag equipment. This work resulted in the G.M. gas carburetters together with a specialized knowledge of gas fuel problems.

In the design of the G.M. gas carburetters the venturi system (which had characterized certain semi-officially sponsored gas equipments) has been completely avoided. Air is drawn in through a lightly loaded automatic valve which also controls the gas intake duct. As the valve is responsive to manifold depression the air intake and gas inlet are adjusted to provide the optimum mixture strength, which remain constant throughout the speed range. A normal throttle is the sole operating control and mixture quality is not altered even momentarily by sudden alterations of its position.

Since the mixture characteristics do not vary with changes of load or speed the carburetter can be pre-set to approximately correct mixture strength; within wide limits a carburetter so pre-set could be used equally well on a diversity of engine sizes.

Following the war the G.M. company applied its acquired knowledge to other aspects of gas carburation, notably the supply of equipment to oil companies for running engines on natural gas, which is a "free" fuel for stationary and portable engines on many oilfields. The next step was to develop a complete gas carburation equipment for the operation of petrol engine test beds. A basic requirement of this duty is that response to throttle movement or sudden loading must be immediate and in dead-beat relationship. Both from the safety aspect and also to avoid flooding the manifold with gas, thereby creating starting difficulty, it is important that gas flow must cease immediately the engine stops.

Changes in mains pressure due to load fluctuations arising from variations in demand from other appliances must not be reflected in unsteady supply with resultant alterations of mixture strength. This calls for an exceedingly sensitive gas regulator or governor. Indeed it was recognized that such an apparatus must be intimately related to the gas carburetter. Commercially available governors were not found to be sufficiently precise in action for the rapidly fluctuating characteristics of automotive petrol engine operation and the result was the development of the G.M. Gas Governor to match the supply to the carburetter.

Petrol for test bed work has always figured as a somewhat costly item and particular attention has been focused upon the substitution of town gas during recent years because of the increasing taxation on petroleum fuels; at the present moment in particular it is unnecessary to emphasize this aspect. Several new and reconditioned engine plants are now using town gas, their names include Rolls-Royce, Rootes Group, Newage, Rover and Ransome.

The G.M. test bed and running-in equipment for use with town gas fuel consists essentially of:

1. The gas carburetter.
2. The gas regulator or governor.

Ancillary units are:

3. Adapters for ease of application and transfer among various engine types.
4. A control throttle.
5. An upper cylinder lubricator.

(Items 4 and 5 are optional.)

Adaptability is a special feature of the carburetter construction, and it is possible to arrange the same unit for either downdraught, updraught or horizontal applications by means of a standardized series of fittings. The main body is an aluminium casting having a mixture outlet on one side and an orifice directly opposite which is blanked by a cap. Air is admitted through ports in the bottom face which also embodies the central gas inlet, the latter having a pre-set adjustable valve. The gas connection is made by a flexible pipe and the coupling can be adjusted to any angle in the horizontal plane. At the top of the body is an idling air adjustment consisting of a rotatable plate with six holes registering with holes in the casting on the hit and miss principle.

To control the outlet of air and gas mixture to the engine is an aluminium gravity drop valve in the form of a disc on the lower face of which are two concentric knife-edged ridges, which make contact with the drilled plate through which air and gas are admitted from below into the mixing chamber. This valve is of light alloy and is of minimum weight, there is no spring and it is readily lifted even by low manifold depression. A hollow stem is fitted to the valve disc and this slides upon a fixed rod, the construction affording the elements of a pneumatic damping device combined with a stop for maximum lift. When raised the valve allows gas and air to flow, the proportions being determined by the pre-set adjustment of the respective apertures. The smaller of the annular knife edges on the valve isolates the gas orifice from the air holes when the disc is seated so that there is no gas flow when the engine stops.

During idling, the annular gap through which the gas passes acts as a control aperture to restrict the amount required so that during starting and idling the carburetter functions on the variable choke system. As the valve is so light and is of non-streamline form it is permanently held clear of the seating by any degree of manifold depression sustained at higher engine speeds; the carburetter then works on the static or fixed choke principle, air and gas proportions being determined by the pre-set apertures. In this condition the gas carburetter gives a straight-line mixture characteristic without variation as a result of speed or load changes, providing that the gas is supplied at slight positive pressure.

It is usual practice on test bed work to couple the gas carburetter to the open air intake of the petrol carburetter, thus making use of its throttle. Should it be decided to attach the gas carburetter direct to the manifold, however, several alternative adapters are available and these may be combined in a butterfly throttle unit with a frictionally lockable control lever. Where the petrol carburetter remains *in situ* however, a rapid changeover to the liquid fuel can be made merely by removing the blanking cap on the gas carburetter opposite the outlet so that full air is drawn through the body; this relieves the depression in the mixing chamber, the valve is not lifted and gas does not flow.

The carburetter described is intended for engines of the small to medium types but a larger model is made, the two sizes covering a range of from 100 cc to 10 litres, thus embracing the entire automotive field.

The larger carburetter works on the same principle but has a box-like main casting with suitable flanges for alternative connections. The idling air adjustment is at the side but the gas inlet is below as in the other model. Air is taken from a downdraught intake to which an air filter can be fitted, the flow passing down an internal duct and then rising through holes in the base of the mixing chamber where, in common with the gas, it is controlled by the same type of gravity-loaded mixing valve.

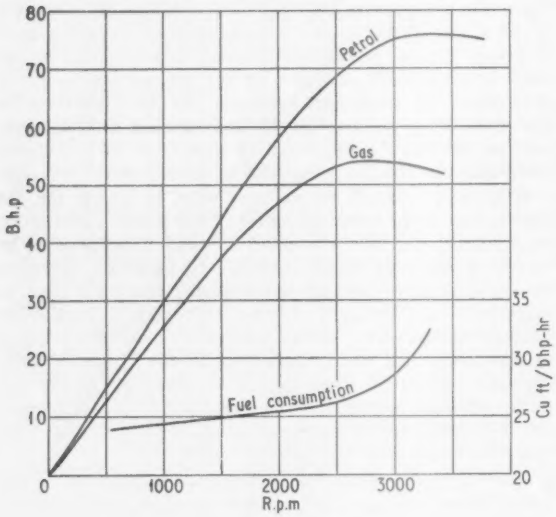
Gas is delivered to the carburetter at a constant pressure somewhat below that of the supply mains by means of a G.M. Gas Governor. This is a simple apparatus consisting of an aluminium body in the form of a flanged dish about 8 in diameter and covered by a cast aluminium lid held by 12 $\frac{1}{4}$ in B.S.F. screws. Gripped between the two members is a diaphragm of rubber-like synthetic material of from 0·001 to 0·030 in thickness and either single or laminated according to pressure input characteristics. The diaphragm carries a central button with a stem projecting into a screwed cap on the cover.

Coupled to the underside of the button is the long end of a bell-crank lever which, through a horizontal push rod, actuates the gas inlet valve. Within the cap on the cover plate is a compression spring by means of which the diaphragm is loaded and the outlet pressure is determined. This governor is designed to reduce mains pressure of 4 in or 5 in water gauge to about $\frac{3}{4}$ in at the carburetter intake.

Engine operation on town gas does not involve any new technique. Starting is very easy and the only unfamiliar aspect is that since the major constituent of the gas is hydrogen its ignitability and rate of flame travel introduce unfamiliar conditions. A hot plug, incandescent carbon or even the burning residual gas still in the exhaust port can, therefore, ignite the incoming charge, the latter effect being related only to an excessive degree of valve overlap; there is little risk, however, of back-firing, under light-load conditions.

Should a backfire occur, the resultant pressure in the manifold immediately closes the mixing valve of the G.M. carburetter so that no more gas can issue to feed a fire. The

closure of this valve also isolates the gas governor, thus protecting its light diaphragm from injury. On the largest G.M. carburetters a separator blow-off valve can be fitted; this releases back pressure and minimizes the impact of the mixing valve on its seating.



Comparison between power developed on petrol and town's gas. The engine tested was a 4.1 litre Commer

Closely associated with the matter of blow-back is the question of sparking plug selection. Owing to the fact that the intake is dry and that there is no benefit from evaporation as when liquid fuel is used, the plugs must be selected for hot and dry running conditions. In short, "hard" characteristics are necessary. Bearing in mind, however, that town gas is mainly used for running-in as distinct from high performance development work, the conditions favour the use of the more standard plugs normal to the engine. This is the more so because the combustion chambers are clean, the valves are in perfect condition and the plugs are new. Indeed, where steady part-load running-in is the main requirement, standard plugs give no trouble. It is only when full load tests of several hours duration are concerned that plugs of the hardest type are necessary.

In the equipment of a test shop or running-in section a prime necessity, of course, is an adequate gas supply correctly related to the number of engines that may be on test at any one moment, taking into account the load factor at which they will be running. The quantity of gas required for one engine, or the rate of supply, can be calculated roughly by reference to the calorific value of the petrol normally used and the already known performance.

For example, a two-litre engine developing 40 b.h.p. at 3,000 r.p.m. may have a specific petrol consumption of 0·6 pt/b.h.p/hr, hence maximum fuel demand is at the rate of 3 gallons per hour, equivalent to 504,000 B.Th.U/hr. Where town gas is supplied at a calorific value of about 450 B.Th.U. per cubic foot the gas supply needed to replace petrol would be approximately 1,000 ft³/hr, ignoring all differences in thermal efficiency and other changed engine conditions. Also, to allow for pipe losses, 25 per cent might be added to the gas requirement, making 1,250 ft³/hr. The cost ratio is as 4 to 6 in favour of gas and may even be a half according to supply conditions.

If 20 similar engines are running at any one time the gas flow available would need to be 25,000 ft³/hr and given this figure the industrial equipment engineer of the gas undertaking can define the main and branch pipe sizes and their permissible lengths in relation to the shop layout that is to be adopted. It has to be borne in mind that gas flow through pipes is a function of both bore and length, although this simple statement is complicated by bends, angles and reducing sockets. Installation of the gas feeders up to the individual test bed governors is thus an empirical matter which rests heavily on the experience of the local gas engineer. A large gas flow meter having a pointer making one revolution of the dial per cubic foot provides a ready means for making a spot check of the rate of individual engine consumption when the unit is running at constant speed and load and can be made with the help of a stop watch.

In connection with sparking plugs mention has been made of the dry mixture and the loss of cooling associated with fuel evaporation. At high load factor this is certainly reflected in an increase of engine temperature but under production test conditions no trouble from this cause is experienced. Obviously where the inlet manifold incorporates an exhaust-heated hot spot the general temperature will rise above normal because there are no liquid fuel globules to be evaporated.

There are several factors in town gas operation which are inimical to full-power testing although the difficulties encountered are by no means insuperable. Gaseous fuel by virtue of its own volume correspondingly reduces maximum air intake and accordingly the loss of volumetric efficiency can be considerable. This varies according to a number of engine design characteristics; for example a very generous hot-spot provision in the form of an exhaust heated inlet manifold has a more adverse effect than the water heated type. On the other hand because of better distribution and improved homogeneity of mixture there may actually be a gain in thermal efficiency.

Unfortunately the relationship between engine performance on petrol and on town gas is influenced by so many of these variables that calculations would have to be made for every individual engine type involved. This would entail a great deal of profitless work in producing data not readily transferable to other and ostensibly similar applications and certainly not having any great practical value.

Of course within the limit of types produced by one organization a working standard of comparison can be reached by taking the normal test figures on petrol then testing the same engine on gas for the recording of optimum results on that fuel. A typical recorded example, for instance, gives 120 b.h.p. at 4,000 r.p.m. on petrol, this being the standard passing off figure. On town gas the same engine delivers 98 b.h.p. at the same speed. Accordingly the latter figure is just as satisfactory for production testing as the higher value on petrol. Over a considerable range of motor car engines of varying types and sizes it has been found that the petrol to gas power output ratio may vary from 15 to 30 per cent, so that each type must be compared individually.

Several by-ways in gas operation have been explored incidental to test bed equipment development. One maker of light horticultural implements powered by two-stroke engines is making extensive use of gas for testing and setting the machines for the somewhat unexpected reason that, being petroil lubricated, they can be sent out with dry tanks so as not to collect dust in transit as happens when the drained petroil leaves a film of lubricant. However, although the dryness of the gaseous fuel is a virtue in that respect, lubrication is still necessary during testing and accordingly a drip feed atomizer unit had to be added to the carburetter to provide the necessary oil spray in the mixture stream on its way to the crankcase. This device is also used on many normal multi-cylinder engines to provide upper cylinder lubrication during running-in.

THE CROSS CHORD TOOL

A New Machining Technique for Bar Turning

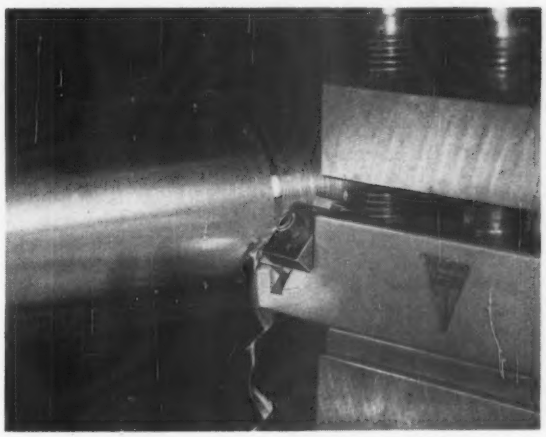
OVER a period of many years the fundamental design of bar turning tools has shown but little change. Detail refinements have been introduced from time to time by modification of tool angles and by selection of carbide grades to suit specific work material, but without radical departure from the orthodox. An exception is the special case of bar peeling, where wide-contact cutters in multi-tool heads give a good finish to the work at coarse feed rates and good production rates are attained. This new "Cross Chord" technique, developed at the College of Aeronautics, Cranfield, will be of interest to all concerned with the problem of bar turning.

The cutting edge is one of four edges of a rectangular block of carbide set at an angle of approximately 50 deg to the axis of the work and tilted at some angle up to 10 deg to provide clearance on the finished diameter of the bar. In the cutting diagram the disposition of the carbide tip is shown at the basic angles. Reference to the section on A-A, at 50 deg to the work axis, shows that the cutting edge C-C lies along a chord of the greater ellipse given by the section of the bar stock and, furthermore, is tangential to the minor elliptic section of the turned portion of the bar. By contrast, a conventional tool has its cutting edge arranged approximately on a line normal to C-C; that is, along the minor axis B-B of the elliptic sections.

It will be noted that the geometry of the cutting edge is relatively straightforward and that the shear planes of the chip are substantially flat. With a conventional tool, shear planes are formed from a face and from a diameter of the work simultaneously and are blended by the tool nose radius. It follows that there is likely to be interference to the chip flow, particularly at high rates of feed. For any given feed and depth of cut, giving a chip of specific cross-sectional area, a Cross Chord tool produces a wider and thinner chip than a conventional tool.

There is a limit to the depth of cut that can be taken with a Cross Chord tool, imposed by geometrical considerations arising from the width of the tool tip and the diameter of the work. The standard tool tip is 0·875 in wide and the table appended gives a range of cutting depths with this tool on work of various diameters from 1·0 in to 8·0 in. Conditions as indicated by an asterisk are, of course, impractical. The setting angles for the carbide tip are all incorporated in the clamp-type toolholder. Secured by a single socket screw, the clamp is carbide faced and also serves as a chip curler. Unusually, the height setting of this tool is not critical. The sole requirement in this respect is that part of the cutting edge of the carbide tip should be above the centre height of the work.

Analysis of the cutting forces, by means of a tool dynamometer, has been made on various alloy steels in the test

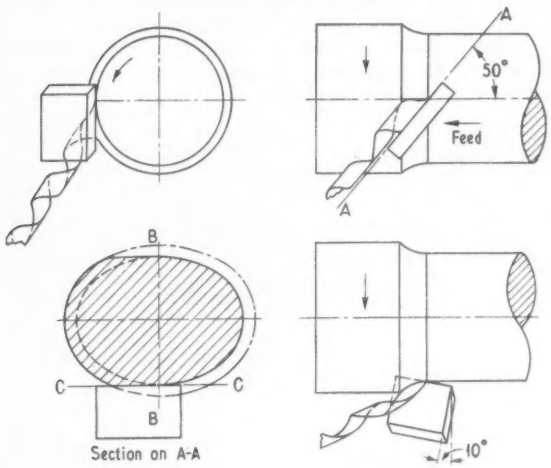


Cross Chord high-modulus tool cutting S.96, 80-ton steel at 600 ft/min. Depth of cut 0·035 in, feed 0·06 in/rev

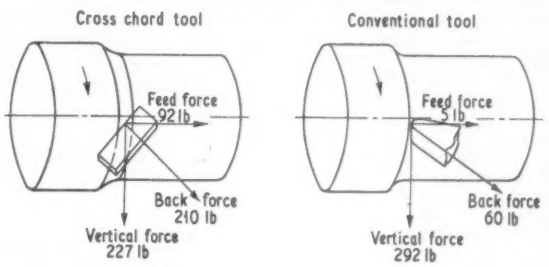
laboratory of the College. The magnitude of these forces when machining S.96 steel at a speed of 260 ft/min, 0·020 in depth of cut, and 0·06 in feed/rev are shown in a diagram, together with those for a conventional tool under similar conditions. In view of the high back force on the Cross Chord tool, a travelling steady may be required in cases where the length-to-diameter ratio of the work is very high.

The performance of the Cross Chord tool is outstanding in respect of long life between regrinds and good surface finish of the work. These characteristics are obtained in operation at high cutting speeds and rates of feed, and make possible relatively high rates of production. Illus-

Diagram showing basic angles, cutting action, and chip flow of the Cross Chord tool



Forces on cutting tools when machining S.96 steel. Speed 260 ft/min, cut 0·02 in deep, feed 0·06 in/rev

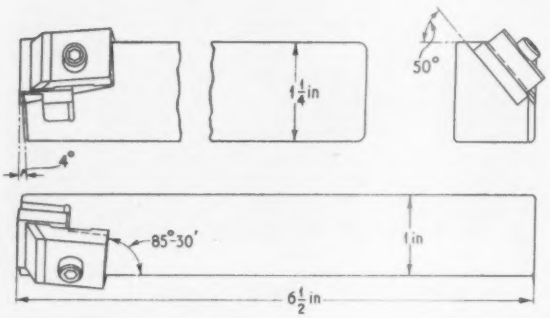


Depths of cut with standard tool on work of various diameters

Bar Diameter	1 in	2 in	4 in	8 in
Depth of cut in	Length of cutting edge ≃ chip width in			
0·020	0·18	0·26	0·39	0·52
0·040	0·26	0·37	0·52	0·74
0·080	0·35	0·51	0·73	1·04*
0·160	0·48	0·71	1·02*	1·46*

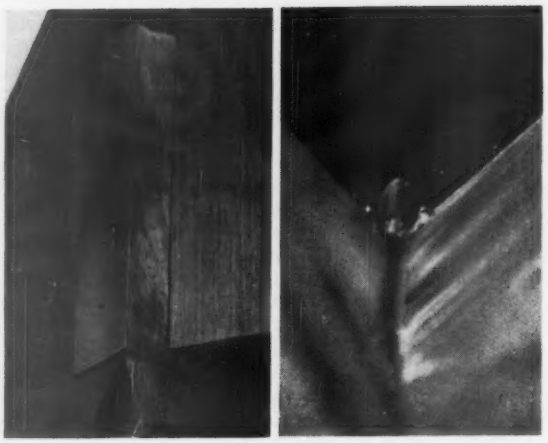
trations show the condition of Cross Chord and conventional tools, of the same carbide grade, after a comparative test on S.96 steel, treated to an ultimate tensile strength of 80 ton/in². In both instances the cut was 0·02 in deep, and the feed 0·03 in/rev. The conventional tool failed after 2 min in operation at a cutting speed of from 600 to 645 ft/min., while the Cross Chord tool was still in perfectly serviceable condition when withdrawn after 6 min 14 sec in operation at the higher speed of from 682 to 774 ft/min. Flank wear was 0·027 in on the conventional tool and 0·0035 in, over a width of 0·01 in, on the Cross Chord tool. The marked superiority of the surface finish produced by the Cross Chord tool is shown by the Talysurf recordings.

In practice, the substitution of the Cross Chord tool for a conventional turning tool necessitates a revision of



Dimensions of the standard Cross Chord tool. The holder is wholly of tungsten carbide to ensure maximum stiffness

planning to allow for a greater number of passes at a reduced depth of cut. The high speeds and feeds rendered possible will, however, more than compensate for the change. Component floor-to-floor times will usually show a reduction of at least 50 per cent. Where the material being machined is susceptible to work-hardening, the thin chip formation requires a higher rate of feed than usual in order to give penetration beyond the work-hardened depth.



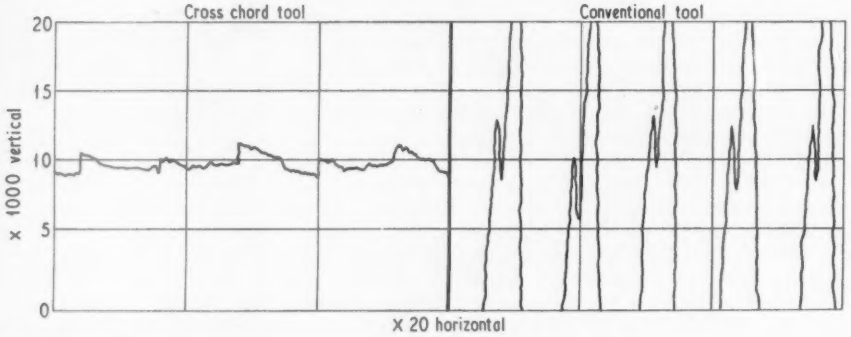
Comparative performance of cutting tools on 80-ton steel. Left, Cross Chord tool after 6 min 14 sec at 682-774 ft/min. Right, conventional tool after 2 min at 600-645 ft/min

The design of the tool incorporates a permanent tool holder and this feature allows a relative freedom to be exercised in the selection of the constructional material. With standard tools the choice is largely governed by the economics of the throw-away tool shank. The Cross Chord tool holder is made entirely of a tough grade of bonded tungsten carbide. This material has a modulus of elasticity almost three times that of steel and an increase in specific gravity from 7·9 to 14·0. Excellent wear resistance is assured by its hardness value of 1,160 D.P.N. Naturally, this choice of material entails a fairly heavy initial outlay, but the increased stiffness and higher mass extend the range of stable cutting conditions sufficiently to justify the additional cost. The overall economics of the tool are very favourable since, in addition to its high performance, the use of a rectangular tip gives four cutting edges which are available without resetting by turning round and by turning over the tip. When the four cutting edges have been used, the tip is re-serviced merely by surface grinding.

Already the tool has shown exceptional results in the high-speed machining of ultra-high tensile steels in the fully heat-treated condition. Where machine tools of adequate strength and rigidity are in good condition, performance limitation is usually that of available power for driving. Modified types of tool to enable the new technique to be applied to classes of machining other than bar turning are undergoing development and test operation. The Cross Chord tool is manufactured by the Production Tool Alloy Co. Ltd., Harlington Works, Sharpenhoe, Bedford.

Acknowledgment is made to the College of Aeronautics, Cranfield, for permission to publish the photographic illustrations and the test data.

Talysurf recordings of surface finish on 80-ton steel at cutting speeds of 650 ft/min. Left, Cross Chord tool; Right, conventional tool



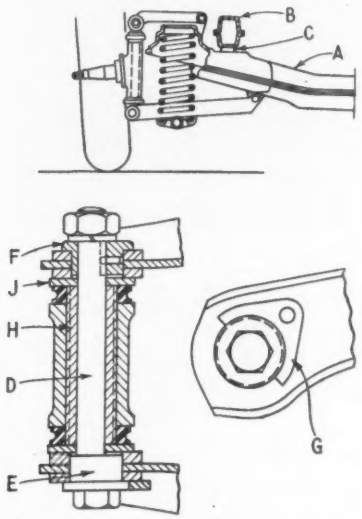
CURRENT PATENTS

A REVIEW OF RECENT AUTOMOBILE SPECIFICATIONS

Adjustment of wheel camber angle

Adjustment of the camber angle of a front wheel independently sprung on transversely disposed wishbone arms is provided by an eccentrically mounted pivot on either of the arms, but preferably the upper arm. Such means of adjustment is particularly applicable to a suspension system in which the axle member is mounted by rubber on the vehicle frame or body structure, or where the axle member is pressed from sheet metal and welded. Both are liable to "settle" after a period in service; the one when the rubber elements are permanently deformed and the other when the weld tensions have slackened.

In the example, the axle beam A is fabricated from sheet metal and is mounted on the vehicle frame B with interposed rubber pads C. The upper pivot for the



No. 755081

swivel pin is constituted by a bolt D formed at one end with an eccentrically arranged bearing portion E having a splined flange and a hexagon head. At its other end the bolt is fitted with a slidably keyed eccentric F retained by a nut and lock washer. The eccentrics take their bearing in the reinforced ends of the wishbone arms and their position, determining the relationship of the pivot bolt to the inner pivot centre of the wishbone, is locked by a tab G engaging the splined flange of the eccentric and detachably secured to the wishbone arm.

The assembly is clamped by the pivot bolt over an externally screwed sleeve H and spacing collars J. Rubber rings between the spacing collars and the eye of the swivel pin seal the screwed bearing surfaces. *Patent No.* 755081. *Daimler-Benz A.G. (Germany).*

Diesel engine cylinder head

With the object of reducing the thermal loading of the piston, the toroidal combustion chamber is arranged in the cylinder head. With this construction the problem arises of the thermal tension of the rim of the restricted orifice of the combustion chamber. Fabricated steel or cast steel heads, and also nickel alloy insert rings, suffer from poor heat conductivity. Cast iron is similar and also has low breaking elongation. Cast aluminium has good conductivity but is liable to crack as the rim cannot freely expand.

An earlier patent, No. 735834,* proposed the use of a forged light alloy insert ring, aluminium-copper or Y-alloy, in a cast aluminium cylinder head. This gave satisfactory results in engines of moderate thermal loading but was still short of requirements in the case of heavily loaded engines; supercharged units, for example.

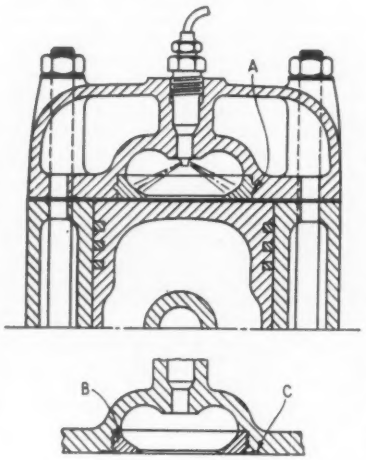
The present invention specifies an insert ring of an "electrode bronze" having the following characteristics:

Heat conductivity ..	45 to 90 per cent of that of pure copper
Tensile strength ..	45 to 75 kg/mm²
Breaking elongation ..	7 to 15 per cent

Such special bronzes contain, in addition to electrolytic copper, cadmium, or chromium, or cobalt to an extent of from 1·0 to 3·0 per cent by weight.

With a cylinder head of cast light alloy the insert ring is cast in, as shown at A. For cast iron, cast steel, or fabricated cylinder heads, the ring B may be screwed in, a cylindrical ring may be pressed in, welded or brazed in, or retained by a screwed ring. In all these methods the face of the cylinder head is rolled over the chamfered edge of the ring, as at C, to lock it in position. *Patent No.* 755086. *S. A. Adolphe Saurer (Switzerland).*

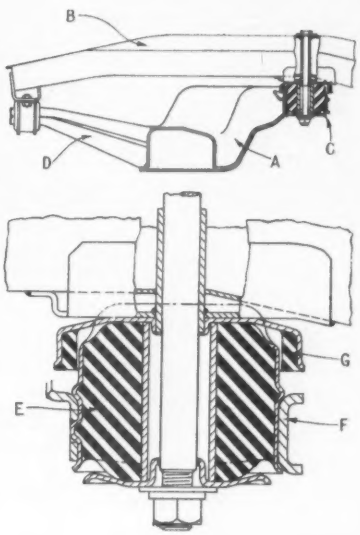
*"*Automobile Engineer,*" August 1956.*



No. 755086

Mounting of front suspension member

The bowed and depressed cross member carrying the independent wheel suspension assemblies is supported from the frame by a pair of laterally disposed soft rubber elements. Forward it is stayed centrally to a rubber bushing on the cross member closing the end of the frame. The soft rubber elements are large in volume and vertically are stressed in shear with a variable rate increasing with loading. Small horizontal displacements are taken by the soft rubber but, beyond a predetermined amount, further movement is resisted by additional elements of a hard rubber. It is claimed that the vehicle bodywork is thus insulated from the high frequency vibrations arising from road



No. 753813

shock, which are mainly responsible for panel drumming.

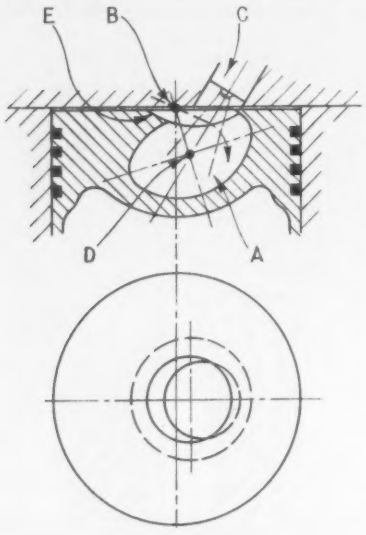
Suspension member A is carried below the frame side member B on soft rubber supports C. Stays D welded to member A form a forward projection which is anchored in a rubber bushing on the front cross member. The soft rubber element E is bonded to a metal internal sleeve, which is clamped between upper and lower thrust plates by the attachment bolt, and an external sleeve by which it is secured to the suspension member by a strap F.

Formed to an inverted cup shape, the upper thrust plate has bonded inside its depending rim an annulus G of hard rubber. Small lateral displacements of the outer sleeve of the soft rubber element E are permitted but further movement is checked by the hard rubber annulus G. *Patent No.* 753813. *Adam Opel A.G. (Germany).*

Diesel engine combustion chamber

Combustion chambers of the direct-injection type and located in the piston crown commonly require a multi-hole nozzle to ensure adequate distribution and mixing of the fuel with the air charge. This chamber is claimed to permit the use of a nozzle of the single-hole or the pintle type, even in high-speed engines of small swept capacity, and to realize a favourably low rate of fuel consumption. The hot combustion gases issuing from the chamber are directed past, not over, the nozzle and thus the arrangement is suitable for air-cooled engines in which the cylinder head temperature is relatively high.

The form of the combustion chamber A is an ellipsoid of revolution about the minor axis of the generating ellipse, which is inclined relatively to the cylinder axis and intersects it at a point B in a plane containing the upper face of the piston. Minor and major axes of the ellipsoid are preferably in the ratio of 2:3. In the cylinder head the injector C is mounted with its axis inclined to the cylinder axis and passing through the centre point D of the

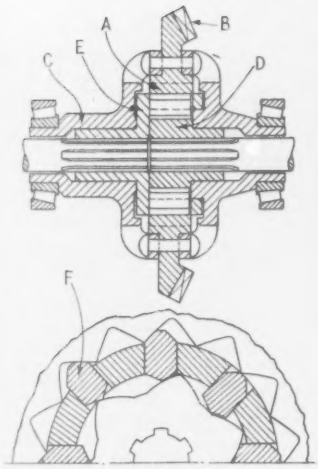


No. 755144

chamber. The axis of the cylindrical throat E is perpendicular to the injector spray axis and the cross-sectional area of the communicating orifice is preferably in the ratio of 1:3·5 to the major cross-sectional area of the chamber. A common transverse plane contains the cylinder axis and, to one side, the axes of the chamber, the throat and the injector. *Patent No.* 755144. *Motoren-Werke Mannheim A.G.* (*Germany*).

Gearless differential

This differential drive is of the type comprising inner and outer coaxial cam members and an intermediate cage member in which are guided a plurality of slidable parts each engaging both cams. By suitably profiling the cam members such a differential may be partially or wholly self-locking in operation and avoid the dissipation of all power at a slipping wheel. Usually, the cage member receives the total driving torque and the two cam members, connected to the axle shafts, each receive a partial torque. A disadvantage of such designs is that relatively steep cam profiles



No. 752997

are required to obtain adequate locking action, resulting in heavy loading tending to distortion and wear.

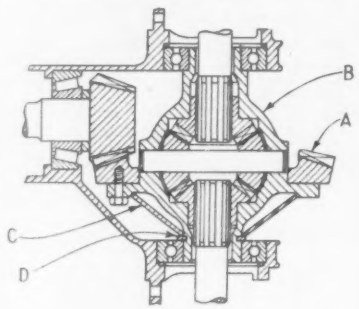
In the present invention the outer cam member takes the total torque and the inner cam and the cage transmit the partial torques to the axle shafts. It is structurally simple, light in weight, compact, and will exert a driving effort on that wheel that has traction by restricting or eliminating the spinning movement of a slipping wheel.

The illustration shows the outer cam A formed integrally with the crown wheel B and to this component are registered and riveted the housing halves C supported in taper roller journals. Inner cam D and the cage member E have a splined connection with the respective axle shafts. Cam A has more than twice as many lobes as cam D and the number of slidable parts F is equal to the difference in number of the lobes of the cams. It is of advantage for each cam to have an even number of lobes.

A feature of the design is that the two cams contact the slidable parts F at opposite sides of their respective lobes. In earlier designs contact with both was on the same side. *Patent No.* 752997. *Maag Gear Wheel and Machine Co. Ltd.* (*Switzerland*).

Mounting of bevel crown wheel

In toothed gears having an axial load component—the bevel crown wheel of a vehicle rear axle drive, for example—this method of mounting will minimize or obviate deflection and enable a substantially constant pitch line to be maintained under varying conditions of load. The gear is supported in the vicinity of the teeth by

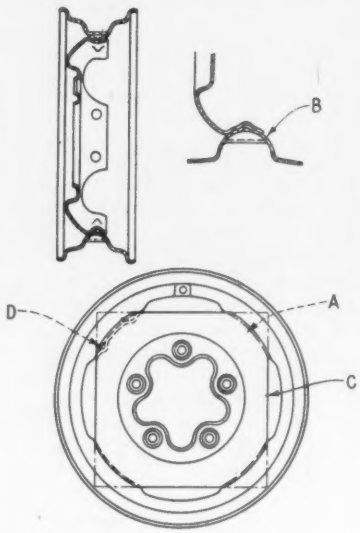


No. 754348

an axially pre-stressed member which imposes an axial load in the opposite direction to and exceeding the axial component of the tooth load.

The illustration shows a vehicle rear axle differential gear in which the crown wheel A is formed as a ring gear and is registered and secured by screws to the flange of the planet carrier B. On the remote side of the carrier flange is formed an inwardly facing shoulder to receive the larger end of a hollow truncated conical member C. This member is pre-stressed by axial compression during assembly and is located and anchored in this condition by the circlip D engaged in an annular groove in the sleeve end of the planet carrier.

It will be noted that member C has a smooth external surface; a desirable feature in a gear running in oil as it minimizes pumping or churning losses. Where it is required to run at high speed in a viscous lubricant, the conical member C may be shrouded by a second conical member (not shown) which is freely rotatable in order to reduce skin drag. *Patent No.* 754348. *Austin Motor Co. Ltd.*

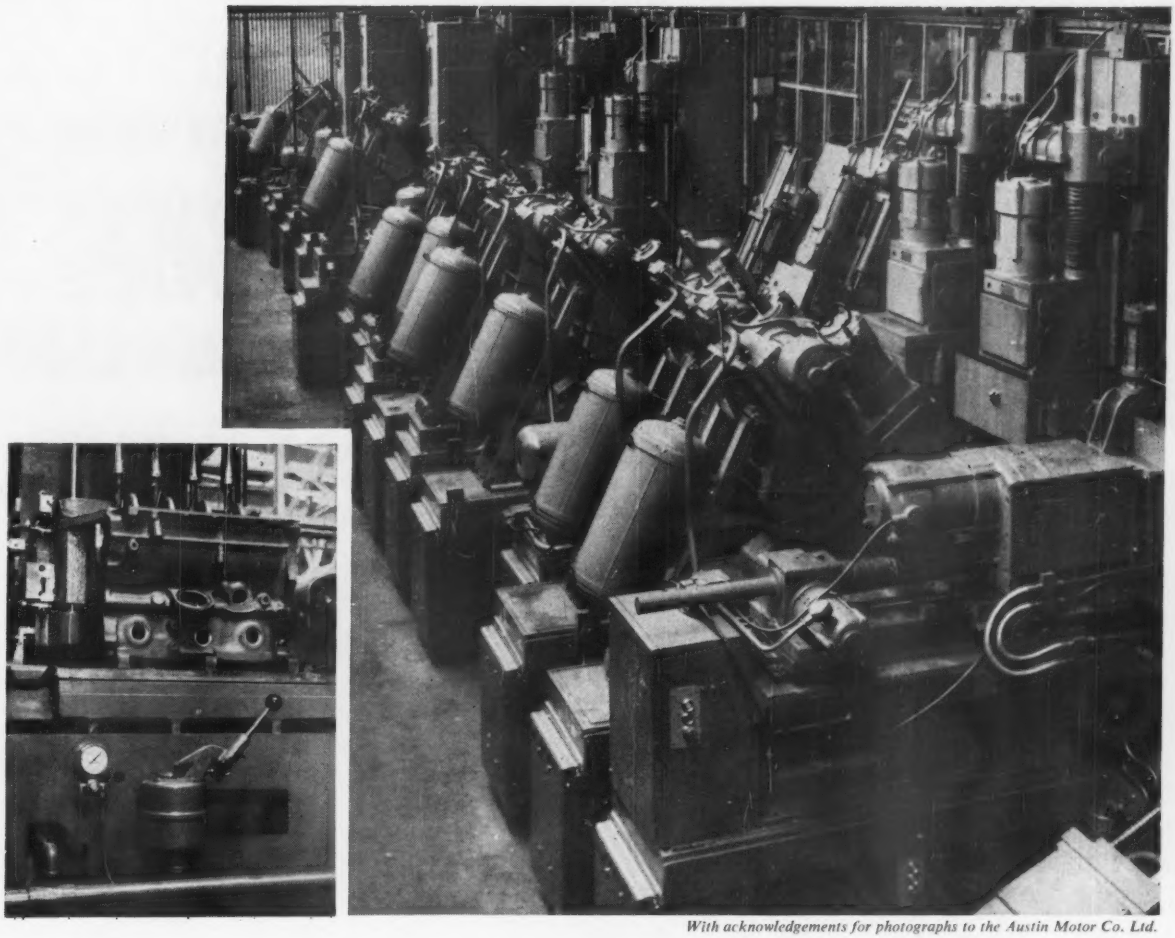


No. 754725

Disc wheel

Economy of material is the aim in this design of wheel in which the rim is formed with inwardly directed depressions to receive the corners of a relatively smaller wheel disc. The well-base rim is provided with four evenly spaced depressions A. Axially these depressions are not part-cylindrical but are formed to a convex profile, as shown at B. As indicated in broken line, the dished wheel disc C is stamped from a square plate, the edge length of which is less than the diameter between opposite depressions A. At its corners the square plate is formed to a concave profile complementary to the rim depressions.

Rim depressions and disc corners are so proportioned that, to assemble the two parts, the disc is guided axially to enter the free spaces between the depressions and is then turned through 45 deg relative to the rim to engage the depressions. This will secure the two parts axially; circumferentially they may be locked by any one of several methods. Common indentations D may be formed in rim and disc, or they may be riveted or spot welded. *Patent No.* 754725. *P. Lemmerz.* (*Germany*).



With acknowledgements for photographs to the Austin Motor Co. Ltd.

AUSTIN AUTOMATION

uses Tecalemit Lubrication

This remarkable machine illustrated here is a thirty-three-station in-line transfer machine, designed and built by the Austin Motor Co. Ltd. Over seventy of these machines are in use with the British Motor Corporation and all are fitted with "Tecalemit-Bijur" Lubrication Systems.

This means that on *each* of the seventy machines more than 500 lubrication points are automatically lubricated by a simple lever movement. Think of the saving in time and labour!

The "Tecalemit-Bijur" Lubrication System may be entirely automatic, or controlled by a simple hand pump. Pipe lines to all oiling points provide a measured quantity of lubricant, at any required interval, through calibrated metering valves. No bearing points can possibly be overlooked so that the life of all bearings is prolonged. The "Tecalemit-Bijur" Systems provide a great saving in both production time, and maintenance cost.

The system is relatively simple to install, even on the most complicated machinery. We invite enquiries from manufacturers and users of all machine tools.

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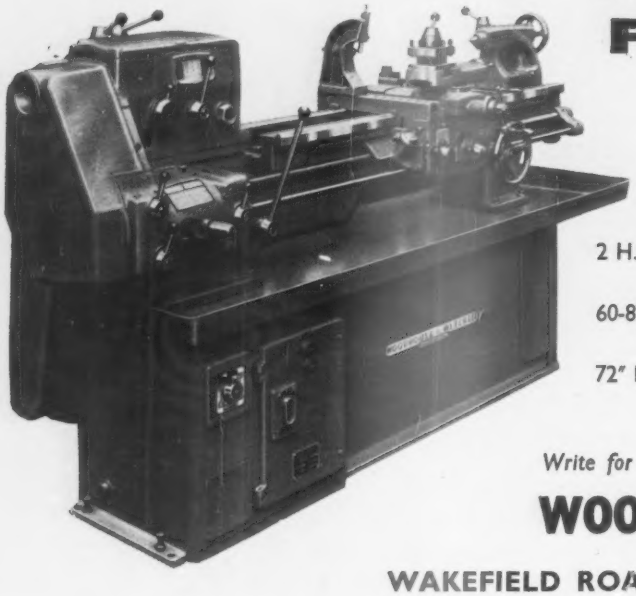

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2 H.P. motor, 8 speeds, 30-437 r.p.m., also alternatives 44-640 r.p.m., 50-750 r.p.m. 60-874 r.p.m. and (when fitted with 2 speed motor) 30-874 r.p.m. Sizes to admit 45", 54" and 72" between centres. The cabinet base illustrated is an optional extra.

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TELEPHONE: BRIGHOUSE 627 (3 LINES) TELEGRAMS: 'WOODHOUSE, BRIGHOUSE.'

WM19

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PHILIPS TYPE SCREWDRIVER BIT for use with ¼" SQUARE DRIVE SOCKET EQUIPMENT

Part No. PSA.202 for No. 2 Bit Size, *11/6.*

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We supply a front axle to match.

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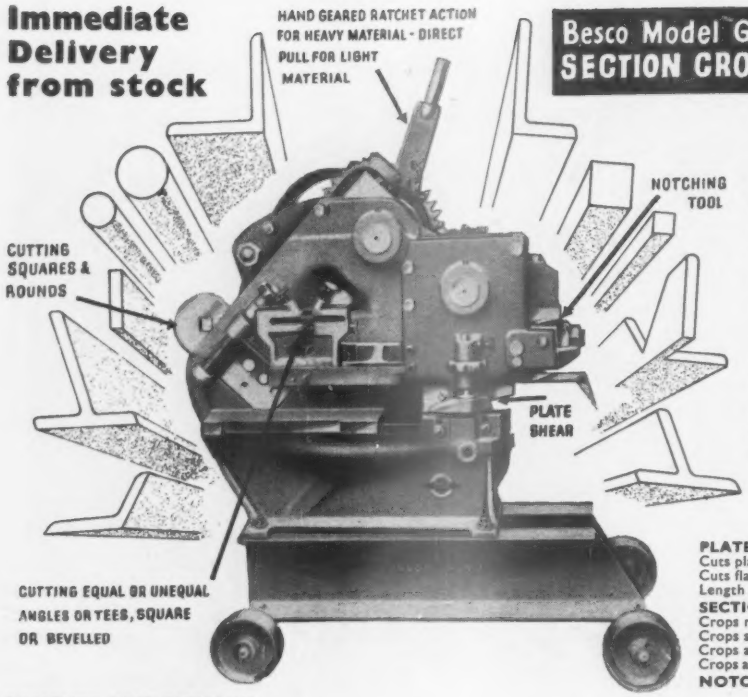
HAND GEARED RATCHET ACTION FOR HEAVY MATERIAL - DIRECT PULL FOR LIGHT MATERIAL
NOTCHING TOOL
CUTTING SQUARES & ROUNDS
PLATE SHEAR
CUTTING EQUAL OR UNEQUAL ANGLES OR TEES, SQUARE OR BEVELLED

Besco Model GA Hand Lever SHEARING, SECTION CROPPING & NOTCHING machines

For use in constructional engineering, etc., and usually mounted on a 4-wheel truck for portable use. Operation by hand lever ratchet action for heavy work; direct lever for light work. **Of very robust construction, with steel frame.** Shears plates of any length or width in successive cuts, also flat bars. Crops angle and tee sections at right angles or on the mitre, and round and square bars. Notches plates or the flanges of angle and tee sections. Vee shaped notching tools are supplied as standard equipment. Square notching tools available at extra cost. With special blades channel and joist sections can be cropped. Adjustable hold-down. Automatic clamping blades on the angle and tee cropper ensure a clean cut.

Model	GA.6	GA.7
PLATE SHEAR		
Cuts plates any length or width up to ...	$\frac{3}{8}$"	$\frac{1}{2}$"
Cuts flat bars any length up to	$\frac{1}{2}$"	$\frac{11}{16}$"
Length of blades	7"	7$\frac{1}{8}$"
SECTION CROPPER		
Crops rounds up to	1$\frac{3}{16}$"	1$\frac{1}{8}$"
Crops squares up to	1"	1$\frac{1}{2}$"
Crops angles and tees at right angles ...	2$\frac{1}{2}$" × 2$\frac{1}{2}$" × $\frac{3}{16}$"	2$\frac{1}{2}$" × 2$\frac{1}{2}$" × $\frac{3}{8}$"
Crops angles and tees on mitre 45° to 90°	1$\frac{1}{2}$" × 1$\frac{1}{2}$" × $\frac{3}{16}$"	2" × 2" × $\frac{1}{2}$"
NOTCHING ATTACHMENT ...	90° notch $\frac{3}{16}$" m.s.	90° notch $\frac{1}{4}$" m.s.
Nett weight on truck	620 lb.	834 lb.

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(57)

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And at MANCHESTER · GLASGOW · BRISTOL · DUBLIN

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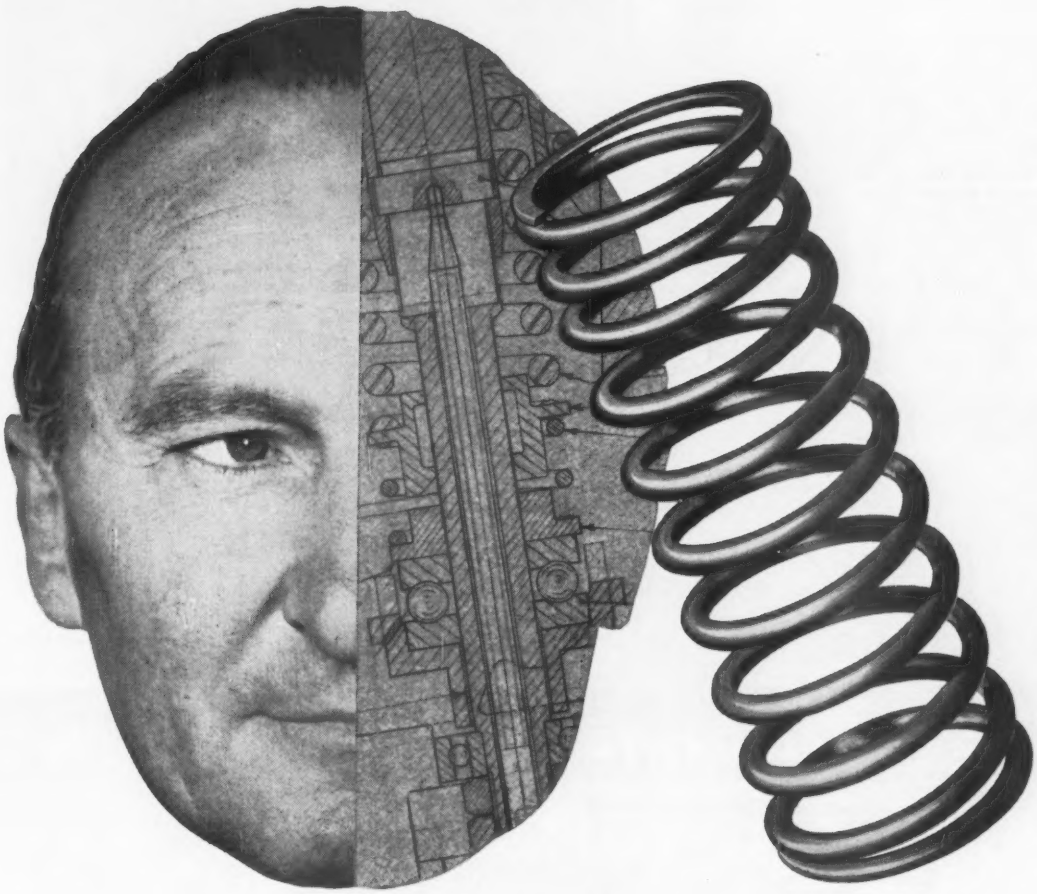

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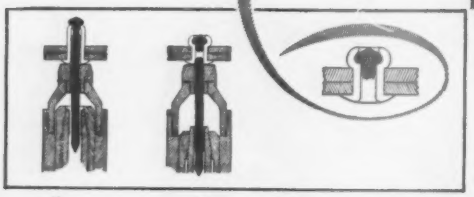
In constant use where speed, economy and simplicity are essential, the "Pop" Riveting System is solving assembly problems in an ever-increasing range of industries.

Almost limitless in its applications, it requires only one operation by one operator, working from one side of the material only, to set or clench the rivet, thereby enabling rivets to be set in positions inaccessible by other methods.

Our technical staff will be pleased to co-operate in solving your assembly problems.



The illustration above shows "Pop" Rivets being used attaching springs for holding moulding finishers—just one of the many applications in the motor industry.

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Consultants: **AIRCRAFT MATERIALS LTD.** Midland Road, London, N.W.1

"POP" is a regd. Trade Mark of Geo. Tucker Eyelet Co. Ltd.

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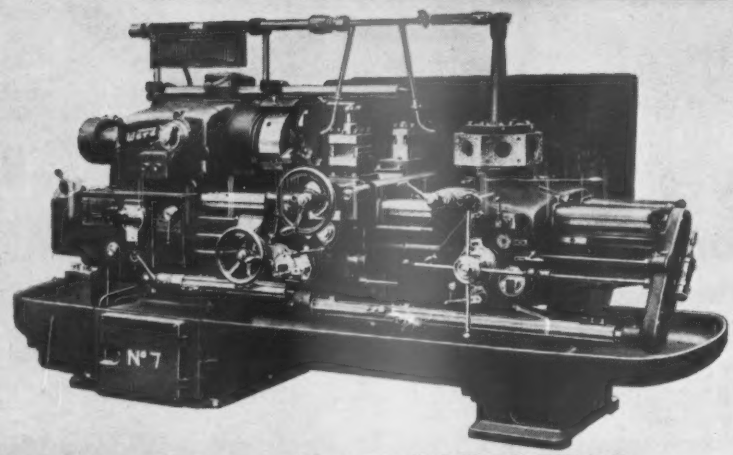

Capacity: 2⅝ in. dia. hole through spindle. 16 in. dia. swing over stainless steel bed covers.

Spindle: Mounted in ball and roller bearings.

Powerful metal-to-metal cone clutches transmit power through ground gears.

New features include patented hydraulic preselecting speed change system allowing for setting any operation speed whilst the previous operation is running. Maximum production is ensured by making full use of Tungsten Carbide cutting tools.

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Pneumaserve reduces the number of operatives required and can be readily adapted to complete automation.
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Weight 52 lbs. Base 12" × 10" Hopper is 22" high and holds sufficient screws for 5-8 hours work.

Atlas Copco AR type Compressors give *more* air to the h.p. than other machines of their class

Choose a rugged Atlas Copco AR Compressor and you can rely on it to deliver more air, h.p. for h.p., than any other compressor of its class. The reason is that these machines have been developed with the aim of low operational costs—both in fuel and upkeep. Take the AR 3 mentioned below. Its power consumption at 100 lbs. per sq. in. is 105 h.p. With this power consumption the supply of free air is 570 cu. ft. per min. Compare performances!

FUEL SAVING PAYS FOR OUTLAY

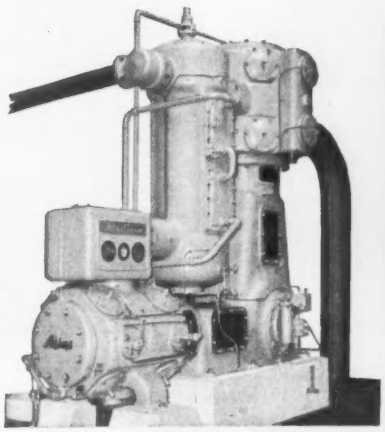
To get the same amount of air from other compressors would, in most instances, require an additional 15 h.p., but 15 h.p. never used mean an *annual saving on fuel bills of £270.* That amount of money represents approximately *one-fifth* of the initial cost of the AR 3. In five years, that's your money back!

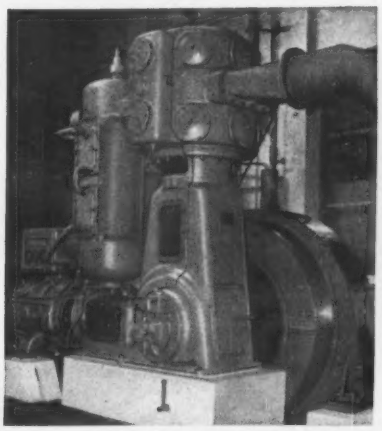
FLEXIBLE AIR SUPPLY

Three-step valve unloading control on smaller models or five-step clearance pocket control on larger sizes permits flexible adaptation to variations in air demand. Also means smooth flow of current to motor.

LOW DISCHARGE TEMPERATURES

Amply-dimensioned water pockets, the two-stage design and streamlined air passages give discharge temperatures below 270°F at 100 lbs. per sq. in.—as compared with 475°F from most single-stage machines. Lower temperatures mean longer valve life and elimination of the risk of air receiver and pipe-line explosions.





An Atlas Copco AR7 Compressor with special centre-mounted dials at the DEMKA steel foundry, Holland. This foundry produces over 200,000 tons of steel and steel products a year. Its products range from 50 ton Forging Ingots and Castings to common wire nails, and it uses a wide variety of Atlas Copco pneumatic tools.

These photographs published by permission of Koninklijke DEMKA Staalfabrieken N.V.

EXTRA-SOLID CONSTRUCTION

High-class Swedish materials and steel throughout; amply-dimensioned parts reduce stresses to a minimum; crankshafts carried on SKF roller bearings; cross-head design with ground or white-metal lined bearings avoids piston side pressure, eliminates cylinder wear.

EASE OF INSTALLATION

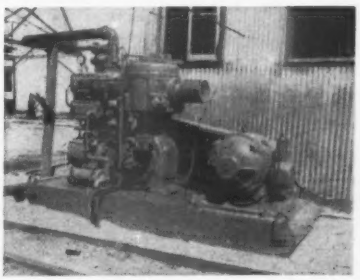
Right-angled, double-acting cylinders combined with counterweighted crankshaft provide a very low weight/capacity ratio and extremely good balancing—thus reducing foundation requirements. So good indeed, that most models can be mounted on a skid underframe and used as semi-portable units without any foundation or bolting-down.

The Atlas Copco Group puts compressed air to work for the world. It is the largest group of companies specialising solely in the development and manufacture of compressed air equipment. It embraces Atlas Copco companies or agents manufacturing or selling and servicing Atlas Copco equipment in ninety countries throughout the world.

For further information about the equipment featured please contact your nearest Atlas Copco Company or Agent. There are Atlas Copco companies in Wembley (England); Paris; Rotterdam; Milan; Brussels; Copenhagen; Oslo; Stockholm; Essen; Madrid; Istanbul; Nicosia (Cyprus); Casablanca; Benoni (Transvaal, S.A.); Ndola (N. Rhodesia) and Bulawayo (S. Rhodesia); Montreal; Paterson N.J. and San Carlos Cal. (U.S.A.); Torreon (Mexico); Auburn (N.S.W. Australia); Wellington; Rio de Janeiro; Santiago de Chile; Lima. If you have difficulty in contacting your local Atlas Copco organisation please write to Atlas Copco AB, Stockholm 1.

PERFORMANCE FIGURES OF ATLAS COPCO AR COMPRESSORS

Type	Maximum pressure lb./sq. in.	Speed at 50 cycles r.p.m.	Low-pressure piston displacement cu. ft./min.	Free air delivery at 100 lbs./sq. in. cu. ft./min.	Power required at 100 lbs./sq. in. h.p.	Cooling water required at 60° F approx. gal./hr.	Weight lbs.
AR 1	120	600	400	330	62	310	3000
AR 3	120	500	715	570	105	500	5400
AR 4	120	429	910	760	138	680	6600
AR 5	120	375	1235	1000	186	880	9000
AR 7	120	333	2120	1740	318	1520	14500
AR 9	120	300	4020	3210	586	2920	26400



A skid-mounted Atlas Copco AR Compressor in operation at Pima Mining Co., Arizona, U.S.A.

Atlas Copco

Manufacturers of Stationary and Portable Compressors, Rock-Drilling Equipment, Loaders, Pneumatic Tools and Paint-Spraying Equipment.

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ICKNIELD STREET

When the Romans invaded Britain they were faced with the problem of creating suitable highways which would give their legions access to the ends of the country. Of the many they built, the most important and famous were the Four Ways; Watling Street, The Fosse, Ermine Street and Icknield Street.

Icknield Street stretched from Norfolk to Southampton and is the one most likely to have been in existence at the time of Caesar's first invasion for it lacks directness, the first characteristic of a true Roman Road. It does not communicate with any ancient town but passes close to some prehistoric remains that are mostly British, such as the Berkshire White Horse and Stonehenge.

It winds from Chesterford through Dunstable, Wendover, along the Chilterns, crosses the Thames near Streatley, and runs on to the Ancient Temple at Avebury.

* Richard Berry have been actively concerned in improving the passage of vehicles over the roads of Britain and the World for over a hundred years. Today the tradition of their skilled craftsmen is being kept alive by the products of their new road spring factory.

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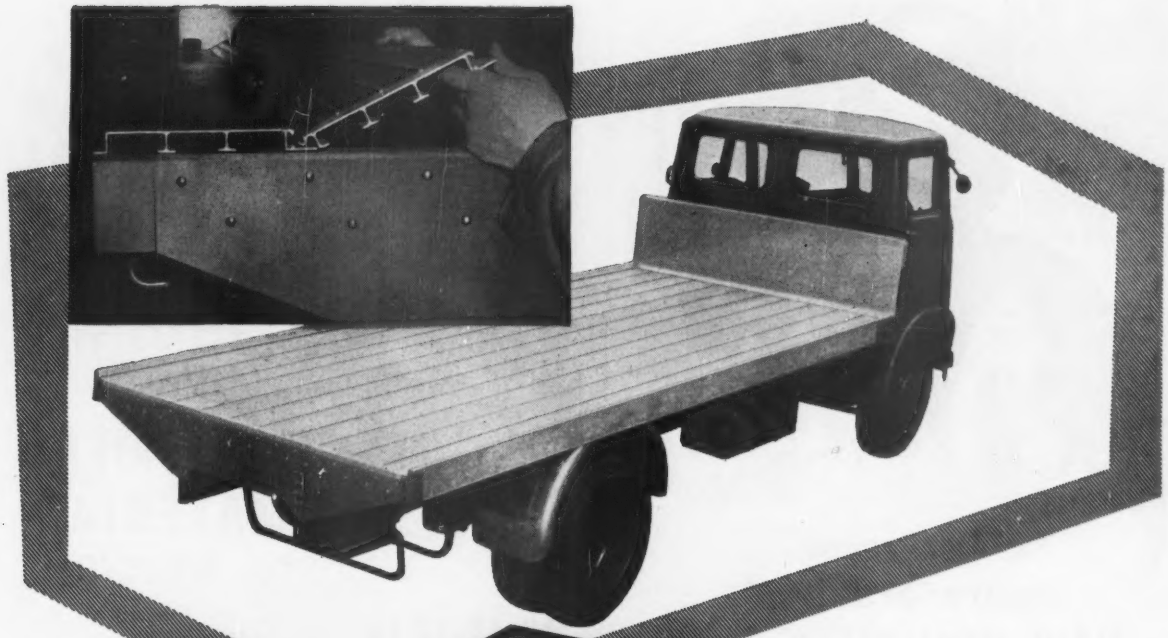

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- Extended 'pot' life
- Replaces leading — no lead poisoning, non-injurious

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PUTTY can be mixed and moulded with the hands or mechanically.

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Osborn 'Mushet' brands engineers' tools are produced from steels manufactured by the Company, and these twist drills, milling cutters, reamers, lathe tools, etc., are known and used throughout the world. Their production is the result of the accumulated experience from generations of craftsmanship and skill.

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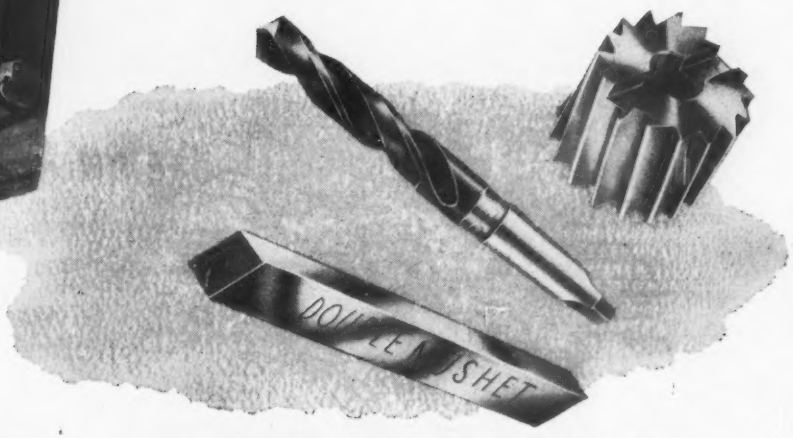

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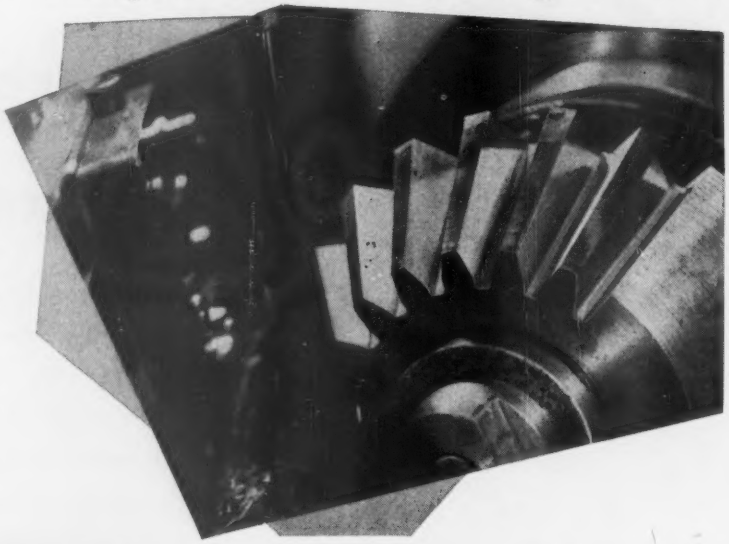
The latest edition of the Fletcher Miller booklet "Cutting Fluids" also contains much useful information to assist engineers. Have you had your free copy yet? Ask for Publication No. SP.173 on your business card or heading.



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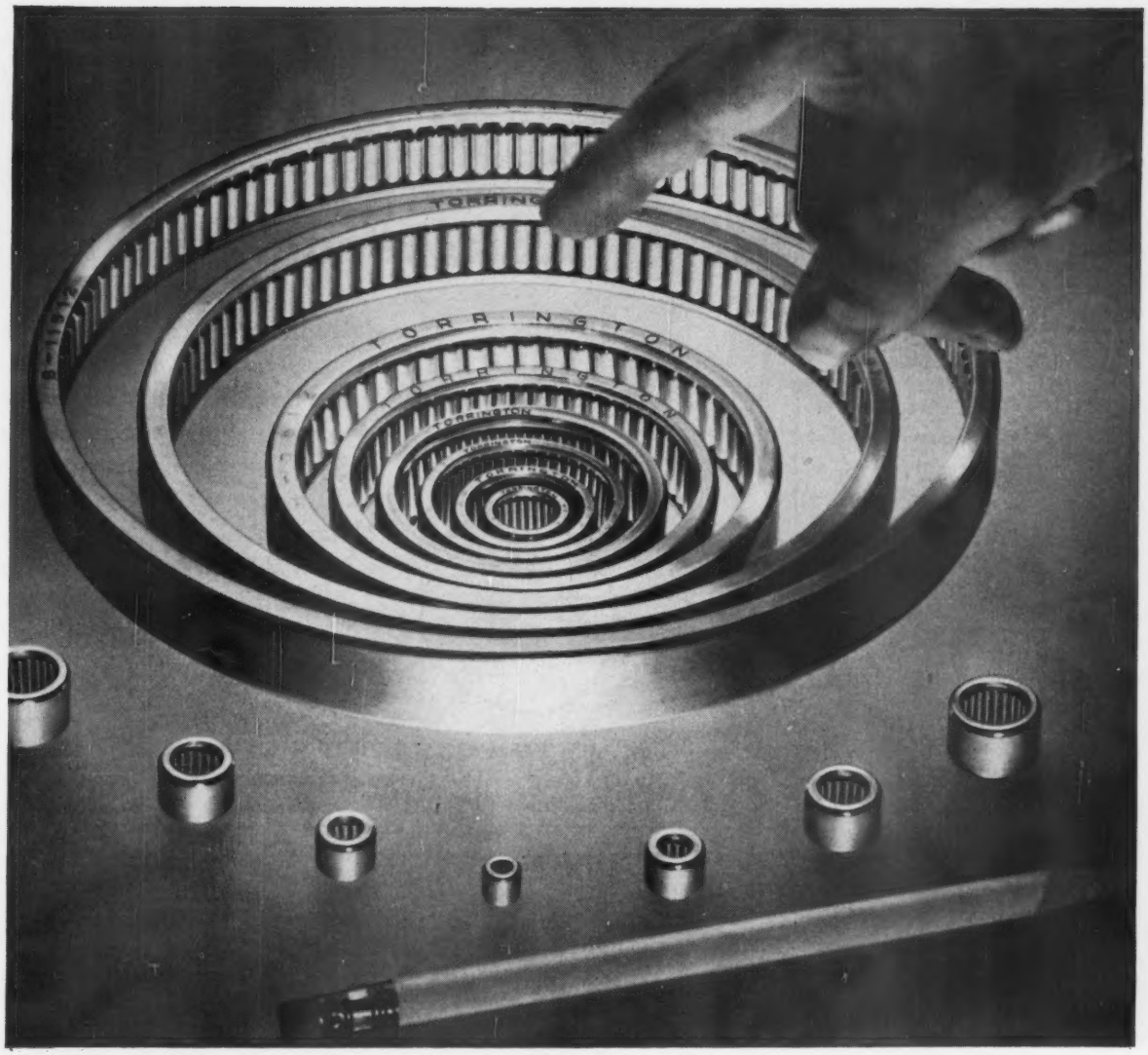

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Give you these benefits

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- low unit cost
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- runs directly on hardened shafts
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MAR 178A

130 SHAFTS FACED AND CENTRED PER HOUR

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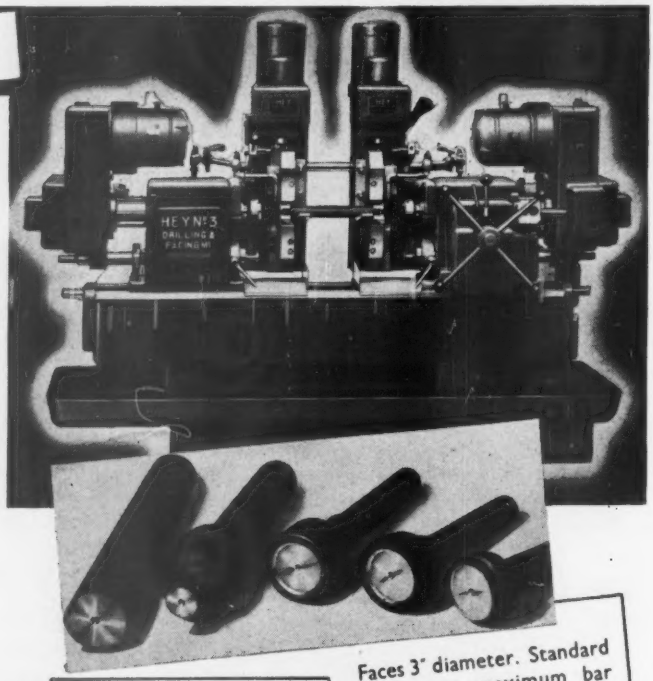
- *Eliminates subsequent facing down to centres or recentring*



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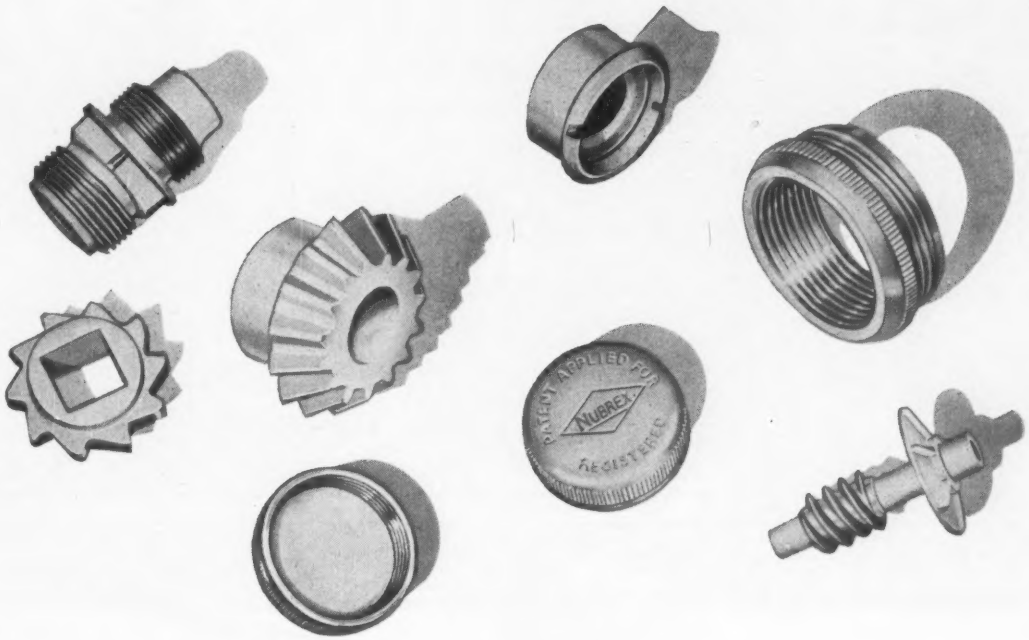

The zinc die castings shown here were cast nearly, if not exactly, to their final form with practically no waste. If they had been machined from bar stock each would have yielded a high proportion of scrap — saleable, yes, but at a considerable loss. Where the quantities are sufficient — and here a die caster's advice must be sought — die casting in zinc alloy can lead to economy in many components like these. As the illustrations show, slots and lettering can be cast in with no need for additional processes. External threads are easily cast but internal threads are often machined where this is quicker than unscrewing cores. In addition strength is good and dimensions are closely held so that only fast, simple finishing operations are needed. The die caster remelts the sprues and runners and thus hardly any surplus metal remains to be disposed of. Cases like these prove that die casting in zinc alloy is the shortest distance between raw material and finished product.

Write for list of members and publications describing the properties and uses of die castings to :—

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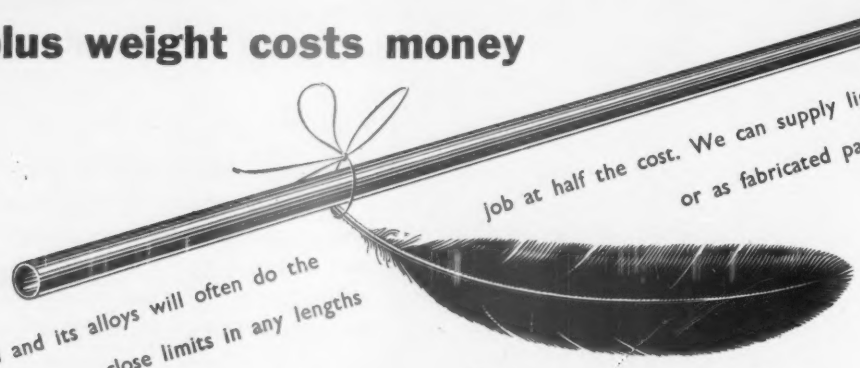

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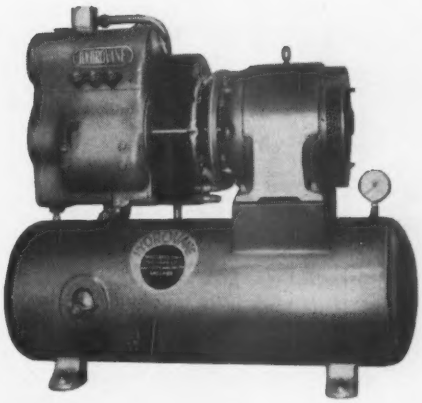

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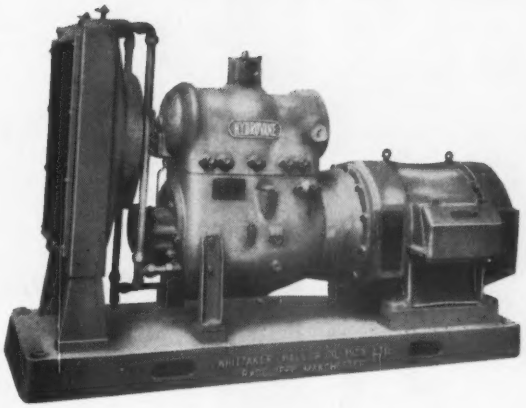

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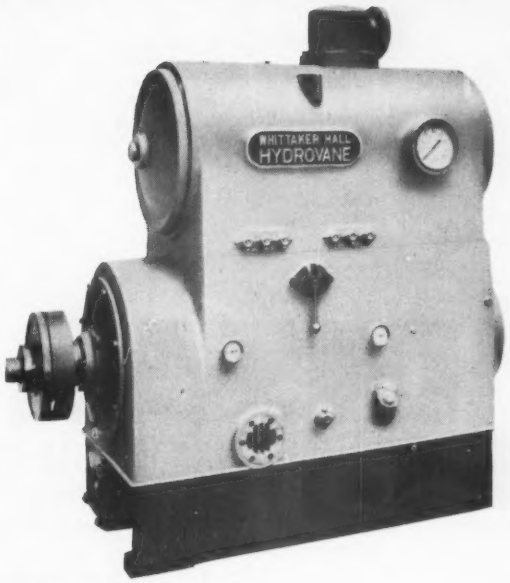

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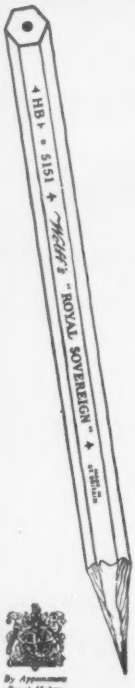

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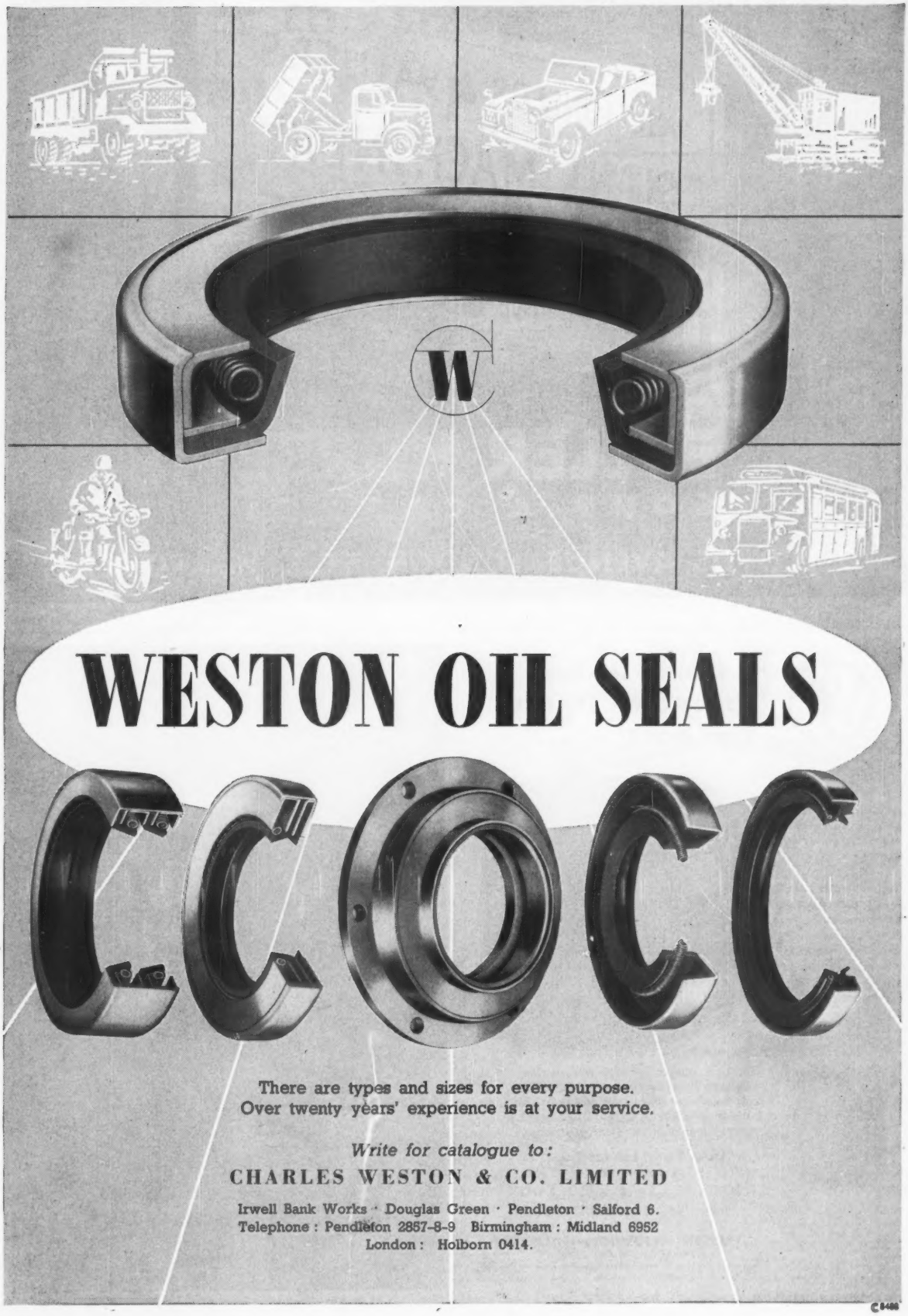
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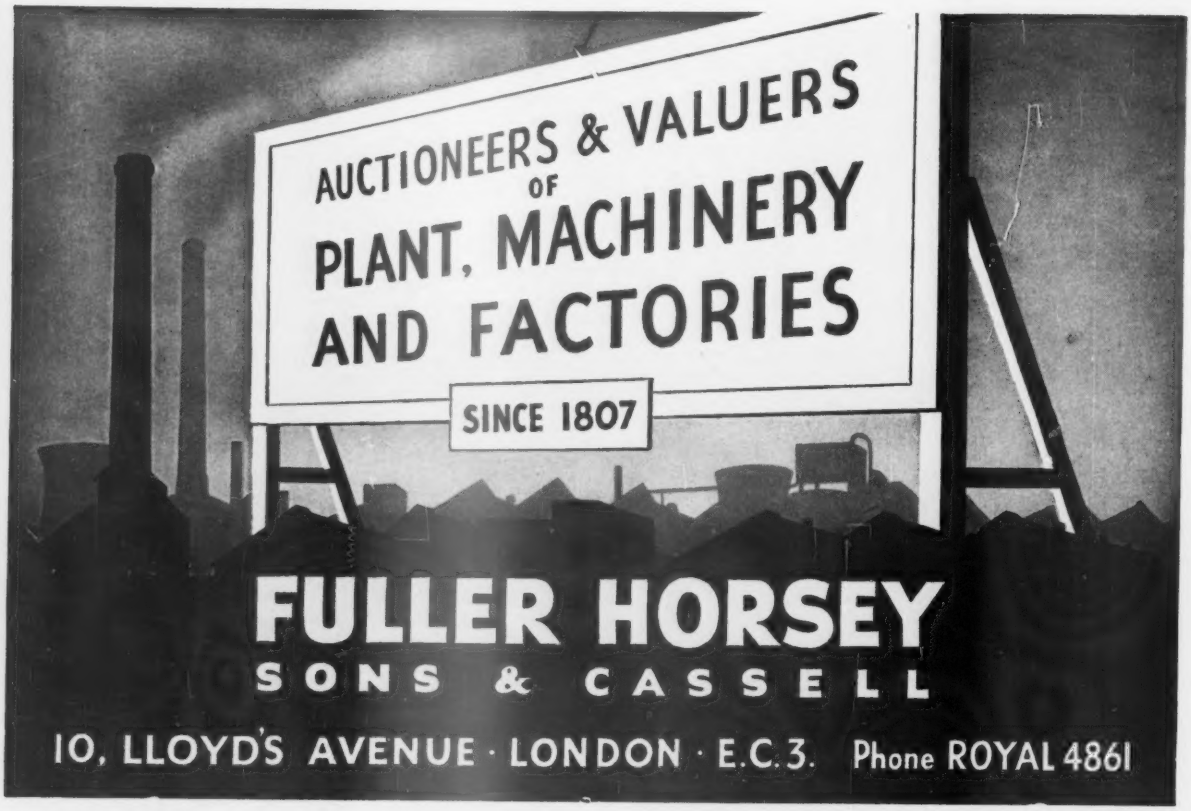

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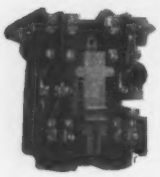

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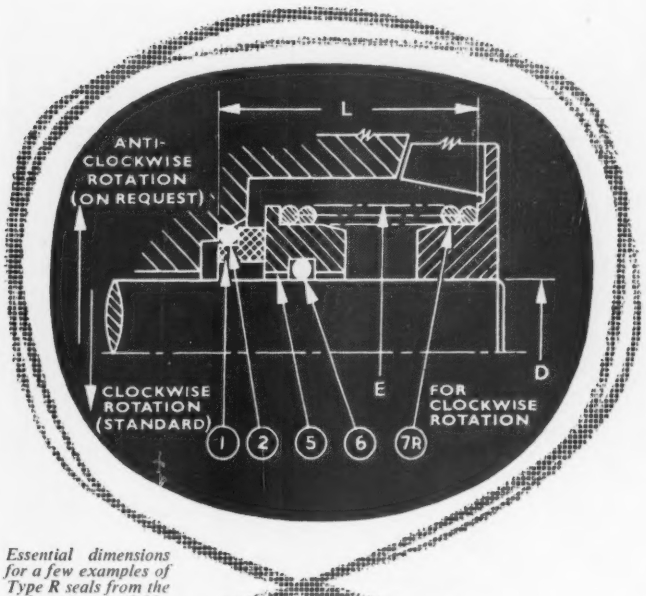

Essential dimensions for a few examples of Type R seals from the wide range available.

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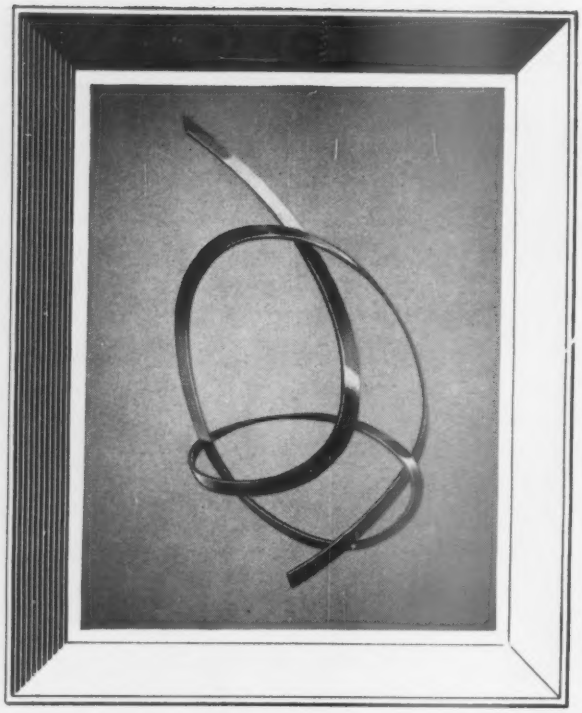

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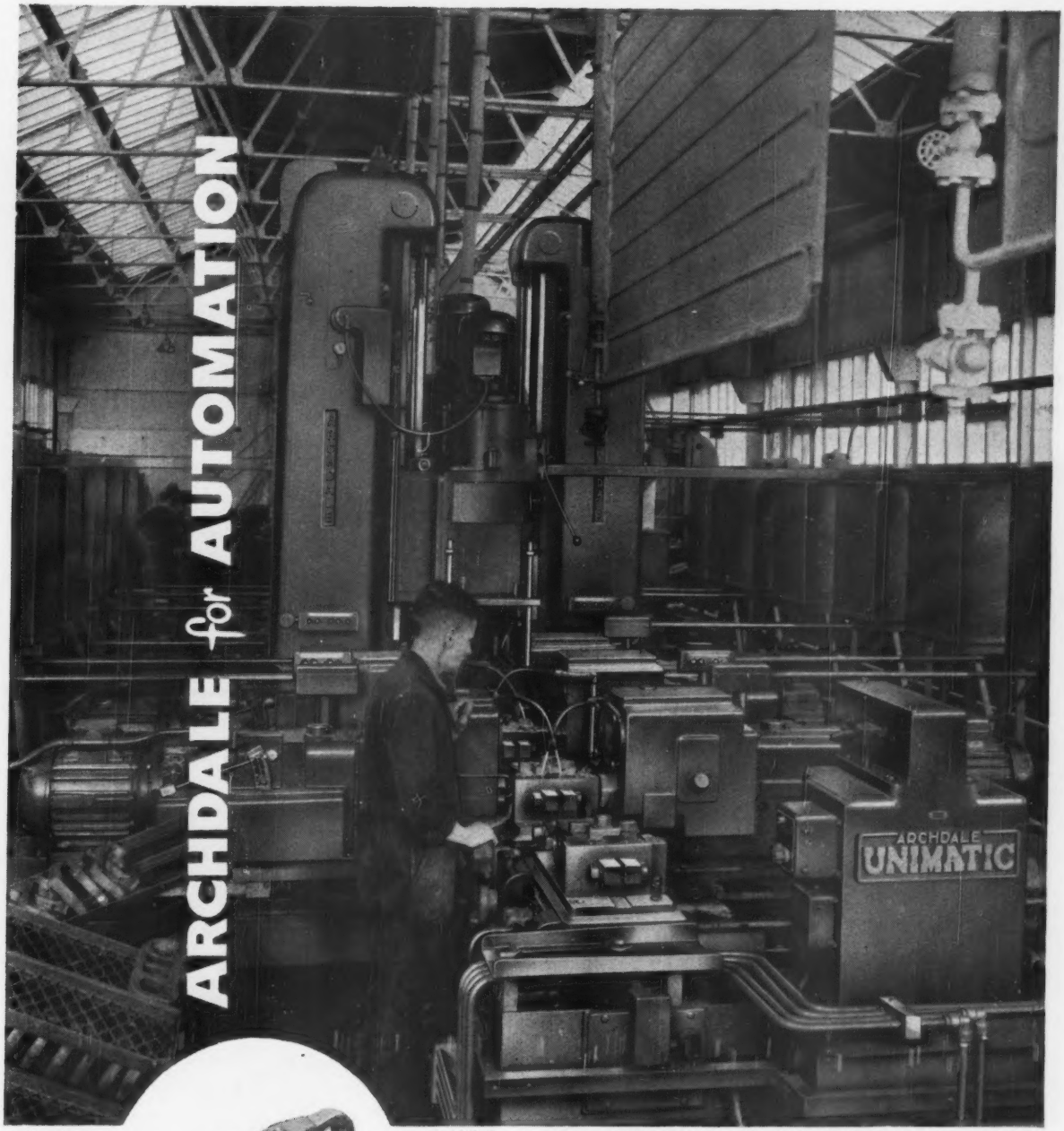

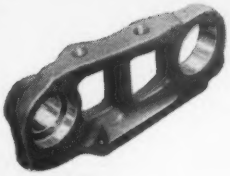

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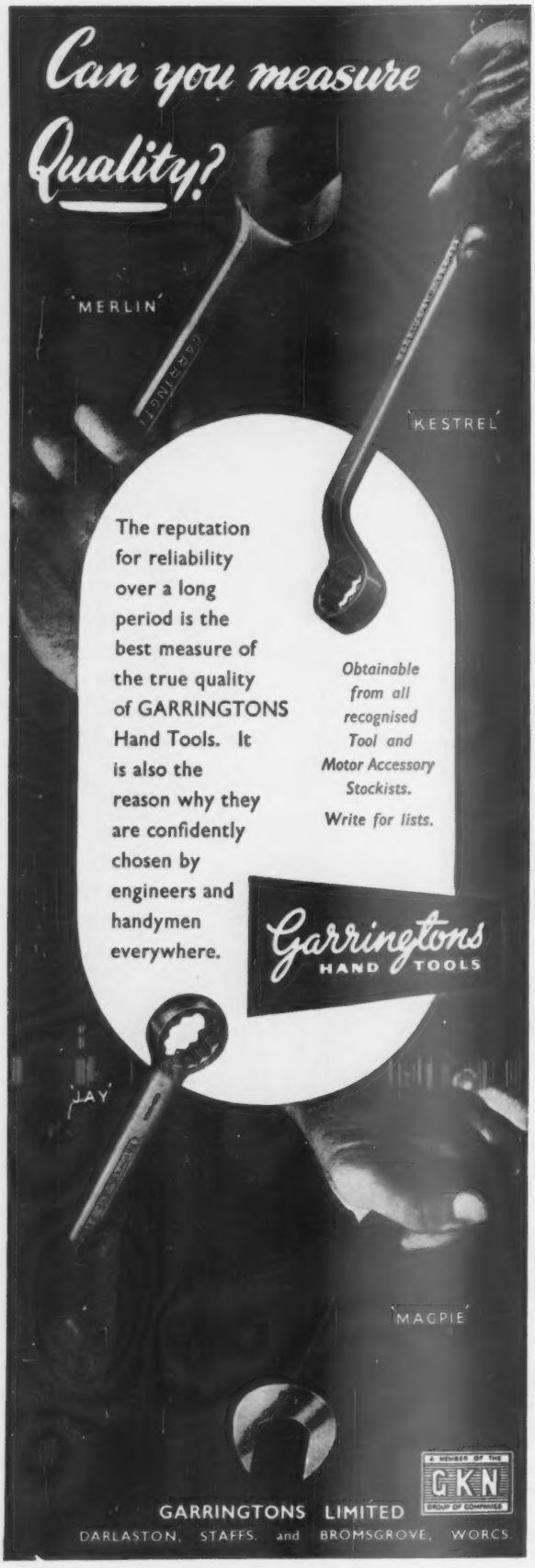
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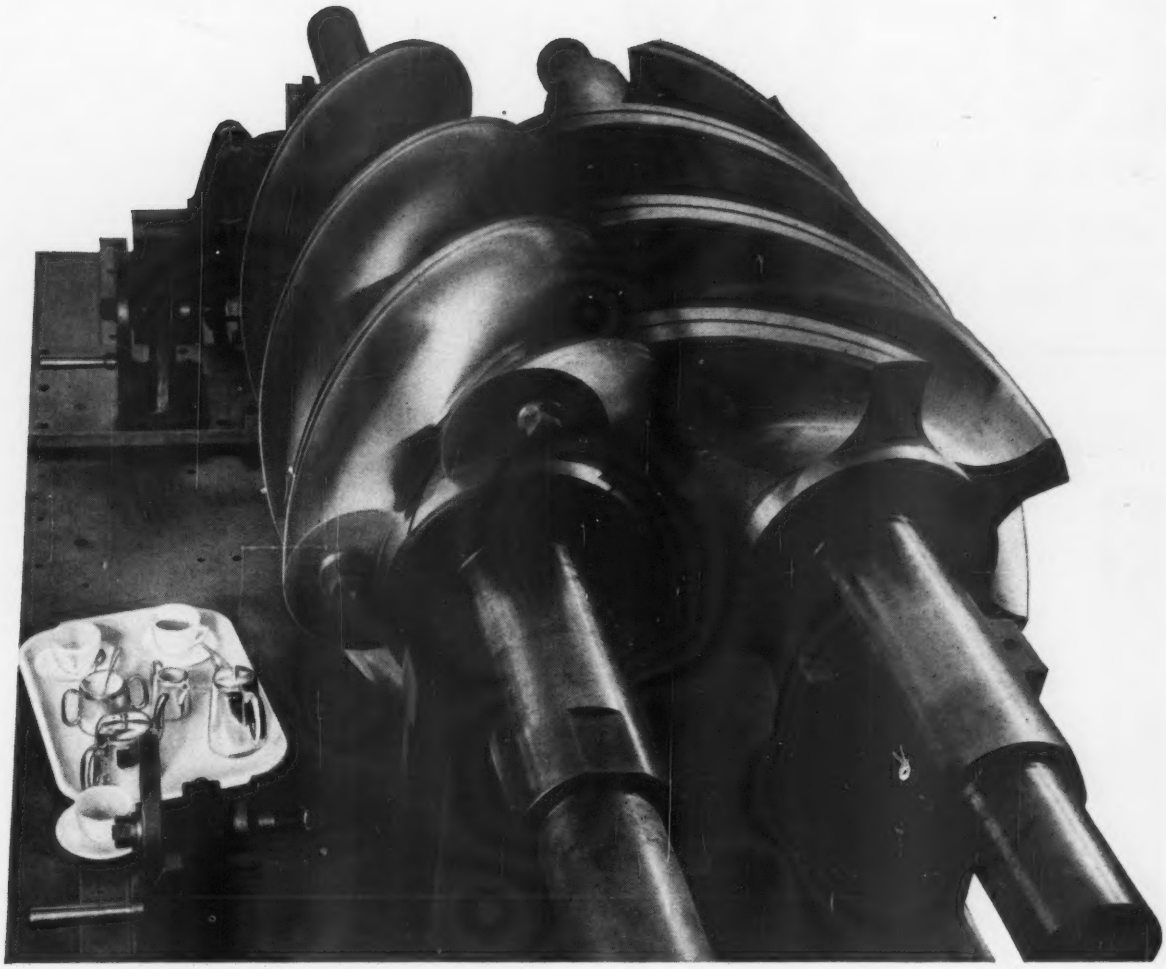

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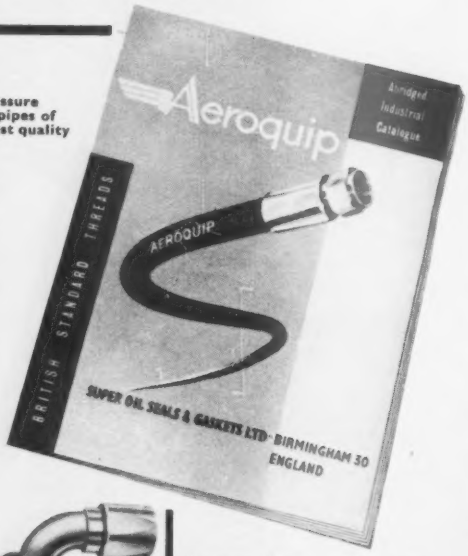

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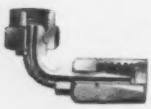

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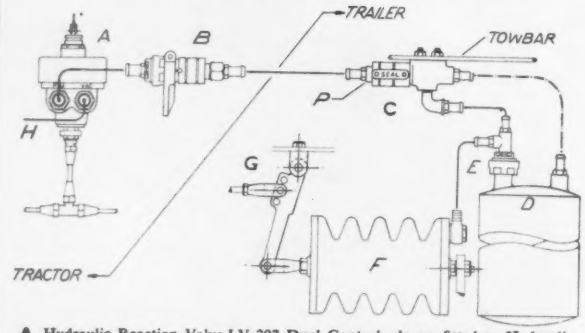

A. Hydraulic Reaction Valve LV 207 Dual Control, shown fitted to Hydraulic Pipe Line on Tractor.

B. "C" type Coupling with Auto. Shut-off Valve, attached to rear of Tractor.

C. Breakaway Valve SBS. 256 (or SBS. 257) attached to Tow Bar of Trailer.

D. Vacuum Tank on Trailer.

E. Non-return Valve.

F. Power Unit on Trailer operating linkage **G** to Trailer Brakes.

H. Hose connecting LV 207 to source of Vacuum. Hose connections shown as solid lines are those used in normal operation of Brakes. The Hose shown in broken line connects the Vacuum Tank to the Power Unit when Valve "C" is operated in emergency.

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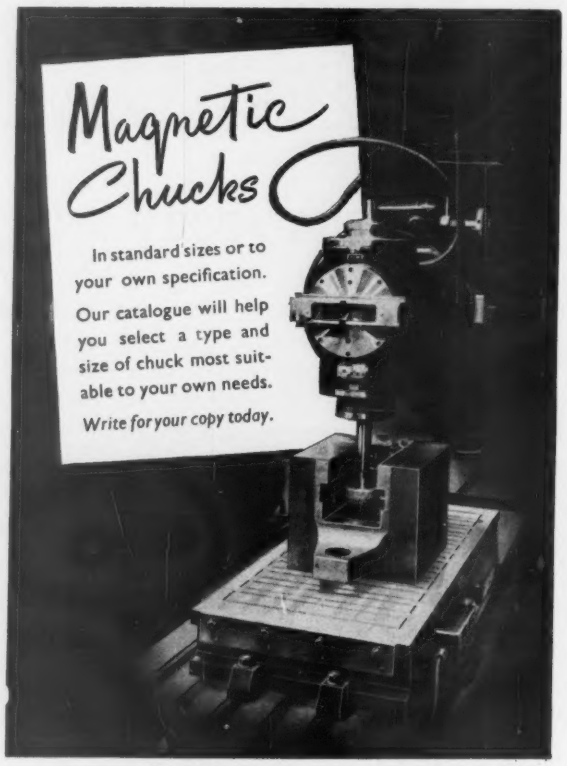
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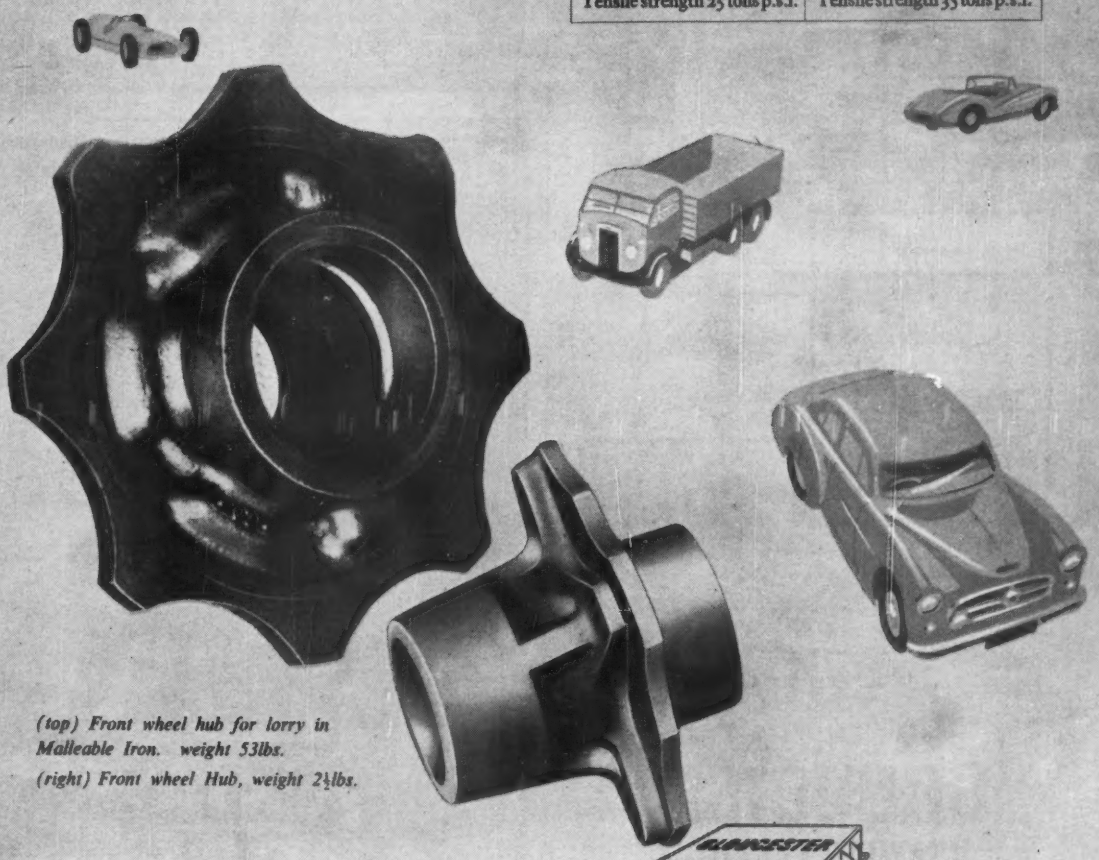
The following are typical Gloucester Malleable specifications.

Gloucester Blackheart Malleable	*Gloucester Lamellar Pearlitic Malleable*
Elongation .. 18%	Elongation .. 5%
Yield Point .. 15 tons	Yield Point .. 22 tons
Tensile strength 25 tons p.s.i.	Tensile strength 35 tons p.s.i.



(top) Front wheel hub for lorry in Malleable Iron. weight 53lbs.
(right) Front wheel Hub, weight 2½lbs.

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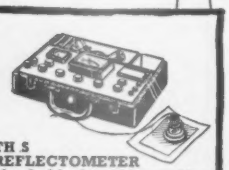


THIS REFLECTOMETER checks blackness for grading.

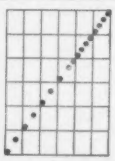
Test charts of pencil shadings, held under the electric eye of the Reflectometer, register on the dial as exact percentages between black and white. Opacity to a fraction of one per cent is recorded.

THIS GIANT PENDULUM proves the smoothness of a lead.

As the point of the lead presses on to the paper the friction slows or stops the pendulum. The smoother the lead, the longer the pendulum swings, thus determining the relative writing smoothness of different lead formulas. The 540-lb. bob swings freely, making 49,920 oscillations from a single impulse before coming to rest.

THIS PRESSURE SCALE breaks points so that you won't.

The pencil is pressed down on to the plate at the normal writing angle. The dial indicates the exact pressure required to break the point.



THIS CHART shows difference in hardness.

This chart illustrates the exact difference in hardness between each degree. Because the technical user requires great accuracy, they are spaced twice as closely from F to 9H.

THIS METER tests length of line.

On this revolving drum the pencil makes a continuous line, which is measured by multiplying the circumference of the drum by the number of revolutions, and thus tests the durability of EAGLE pencil leads.

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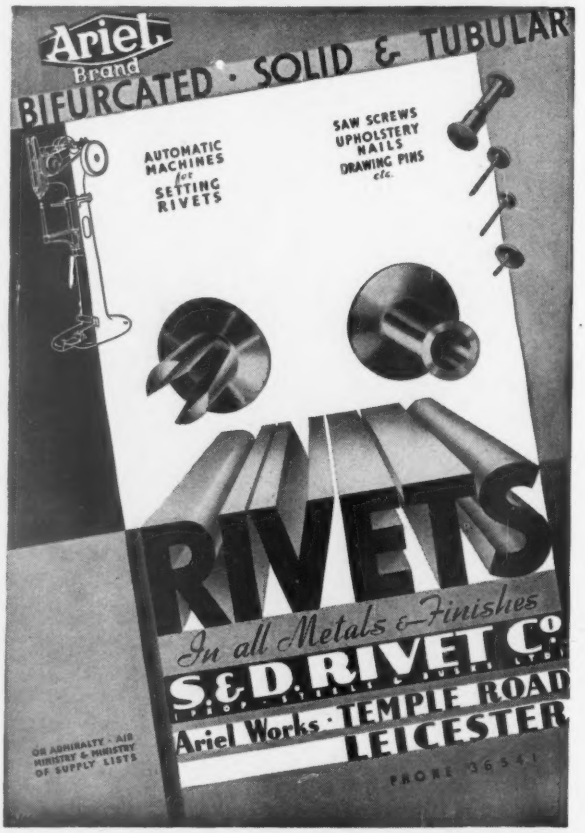

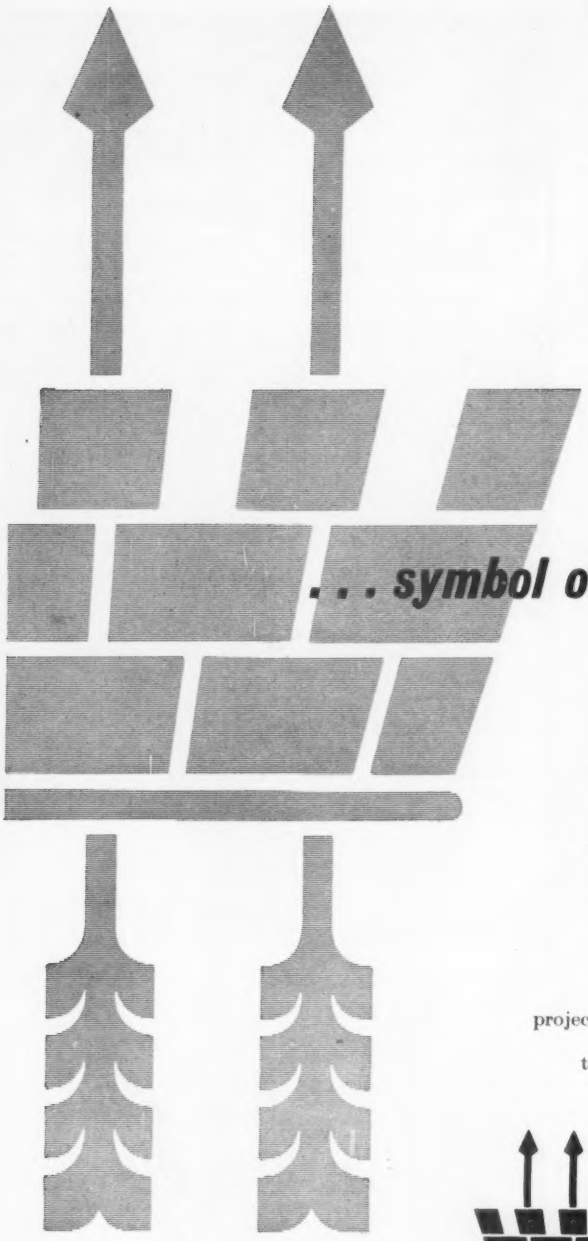

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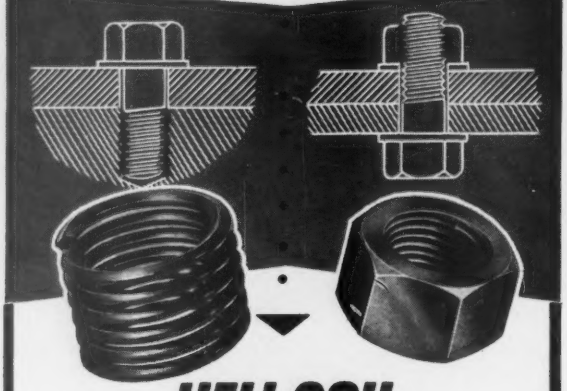

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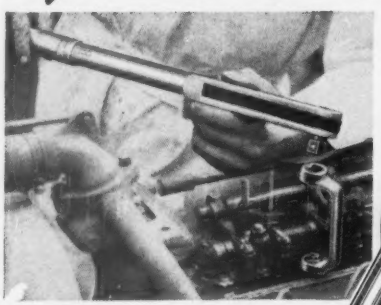

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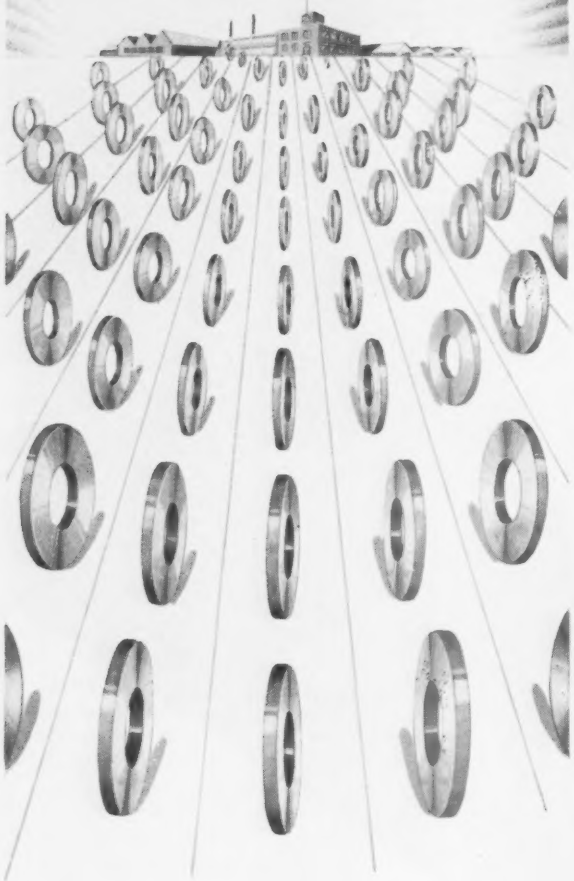

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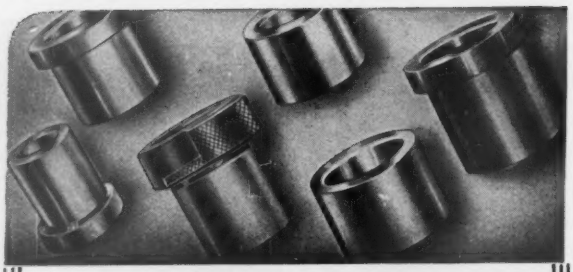

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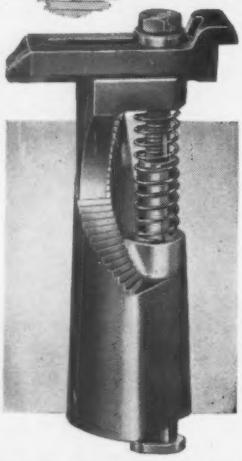

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1/6	7 - 10"

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2/3	1½ - 3"
2/4	2⅜ - 5¼"
2/5	4¼ - 7⅜"
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3/5	8 - 12½"

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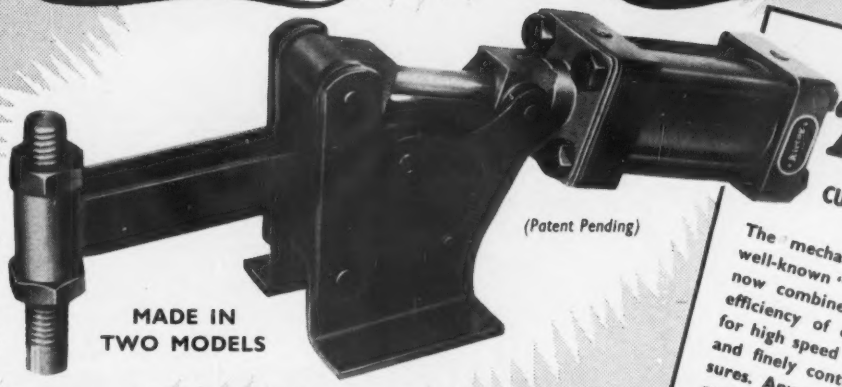

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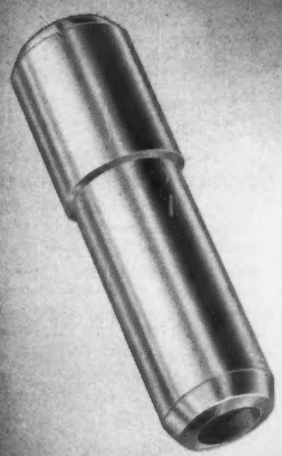

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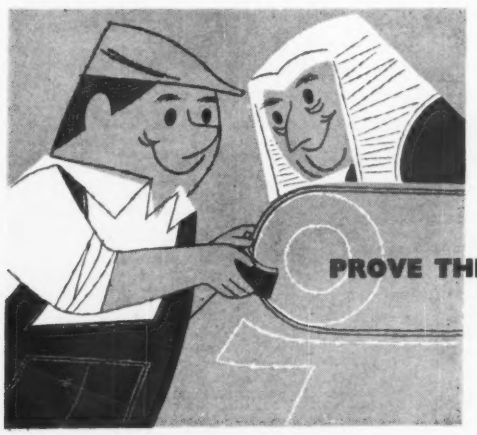

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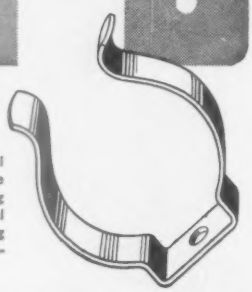

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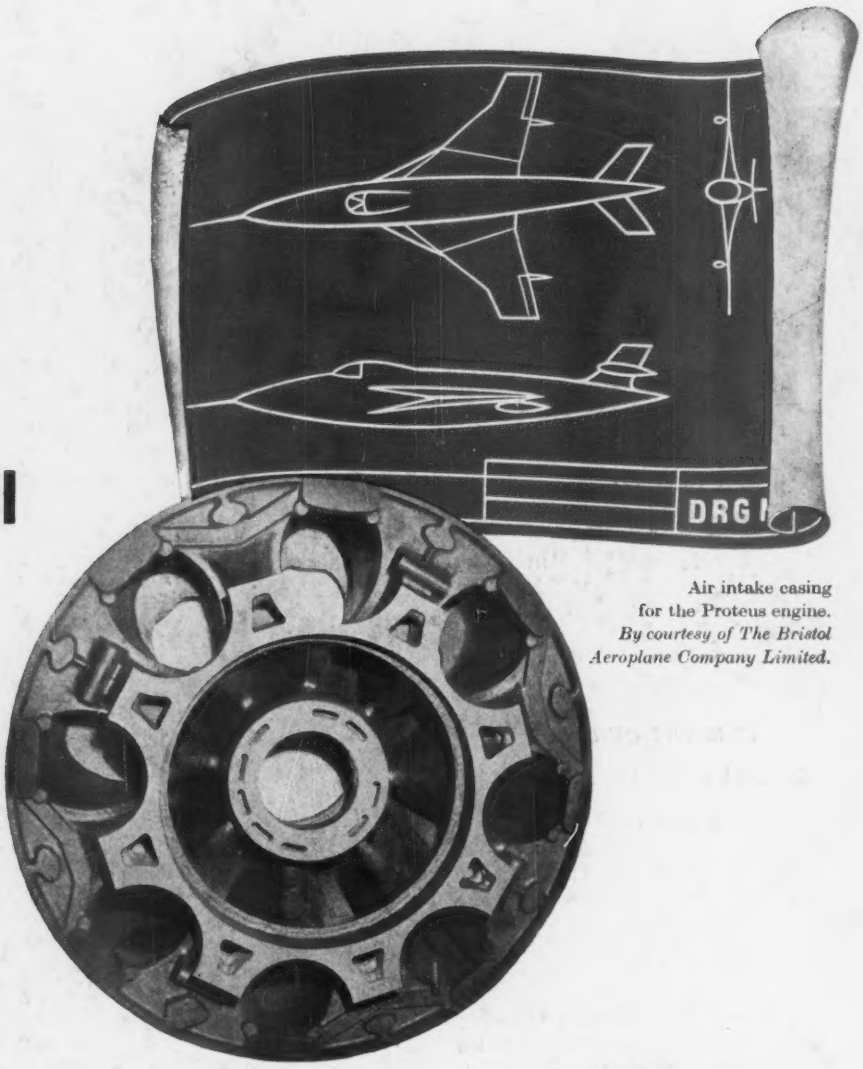

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